Sampling Strategies for Estimating Subsurface Contaminated Soil Volumes Associated with the Extrusion Plant

1.0 Introduction

The RMI Titanium Extrusion Plant facility (RMI) consists of 25 buildings covering approximately seven acres. The facility is located in Ashatabula County, Ohio, northeast of the city Ashtabula. Uranium extrusion operations began for the US Atomic Energy Commission in 1962, and continued until 1990. The extrusion plant was the main focal point for these activities. The extrusion plant is currently slated for demolition and disposal. The site has been designated by the DOE Ohio Field Office as the Ashtabula Environmental Management Project (AEMP).

The principal contaminant of concern for soils at the AEMP is uranium. In addition, there is some evidence of technetium-99, lead and VOC contamination. The base-line closure plan for the site estimated 27,900 cubic yards of contaminated soil requiring excavation. A more detailed review of plant processes, however, identified several areas beneath the extrusion plant that might have a significantly greater volume of subsurface soil contamination than originally included in the base-line estimate. The current base-line (FRP 4.0) has estimated a total of 71,330 cubic yards of contaminated soil that still remain to be remediated at the site. The uncertainty about total volumes of contaminated soils that must be addressed has significant implications for remediation budgets and schedules at the AEMP.

The purpose of this document is to provide recommendations on cost effective sampling strategies to better estimate contaminated subsurface soil volumes for soils beneath and immediately adjacent to AEMP buildings.

2.0 Sampling Goals

The principal objective of the proposed sampling work is to provide the site with an improved estimate of contaminated subsurface soil volumes immediately adjacent to and beneath AEMP buildings. This estimate should include both a most likely estimate of contaminated soil volumes, as well as an upper bound on what the volume of contaminated soil could be. The difference between the most likely estimate and the upper bound represents the uncertainty associated with the most likely estimate. The site has a fixed budget for this round of sampling work. The goal, then, is to attain maximum uncertainty reduction within the limitations of that budget.

A secondary objective of the proposed sampling work is to produce technology performance information that will facilitate the deployment of the proposed technologies at other DOE sites, consistent with ASTD goals. In particular, the information generated by the proposed work should be sufficient to determine MDLs for the proposed cone penetrometer NaI sensors for uranium. The proposed deployment of the sensor at the AEMP is as part of a GeoProbe system. The information should also be sufficient to identify operational characteristics of the technologies that are being deployed, (e.g., physical limitations of the technologies, information production rates, etc.).

Since closure is the ultimate goal of the site, the additional data collection should be consistent with, and supportive of the closure protocols that will be used once remediation is complete.

3.0 Existing Information Summary

Existing information pertinent to this document can be broken into two categories: information collected as part of past characterization efforts, and information associated with the development and refinement of the current base line volume estimate, FRP 4.0. Figure 1 shows the locations of buildings at the AEMP, active remediation areas, and the location of the CAMU (former evaporation pond).

Past Characterization Data

Several previous investigations have yielded information pertinent to the volume estimation process for buildings at the AEMP site. These are summarized in the following reports:

- RFI Equivalency Document and Supplemental Hydrogeologic Assessment, Eckenfelder, Inc., 1989. While the focus of this work was primarily on groundwater issues, soil samples were collected in the CAMU area that yielded some uranium information. Also, these reports contain a fairly descriptive analysis of the subsurface lithology in the vicinity of the AEMP buildings, based on monitoring well logs.
- Site Characterization Report for RMI Titanium Company Extrusion Plant, RMI Environmental Services, 1995. This report summarizes all information available up until 1995 regarding the presence and distribution of contamination across the AEMP site. Included are results from soil bores, closure data collection activities in areas presumed unaffected, and surface scans conducted on a grid across the site.
- Subsurface Investigation of the RMI Titanium Extrusion Plant, North Carolina State University, 1999. A subsurface investigation was conducted in the vicinity of the CAMU in 1998. A series of soil bores and monitoring wells were installed as part of this investigation, yielding total uranium results for these locations at depth.

In addition to the data collection efforts detailed in these reports, more recently EarthLine Technologies installed a series of soil bores and monitoring wells in the CAMU area, and some data was collected beneath the Northwest Warehouse as part of a technology demonstration project.

The relatively large number of monitoring wells in the immediate vicinity of the AEMP provides fairly detailed information on subsurface lithology. In the immediate vicinity of the AEMP, bedrock is approximately 30 feet deep and consists of shale. Overlying this shale is a glacial till. Near the plant, the upper six or eight feet of glacial till are composed of silt with clay and some fractured or broken shale fragments. Also within the vicinity of the plant, large vertical and minor horizontal factures have been reported at depths of nine to twelve feet. These fractures are typically oxidized, occasionally wet, and most likely produced by weathering of the till. Beneath the near surface silt, the till is composed of dark gray, very dry to moist, plastic clay with varying amounts of silt and reworked shale. The glacial till also contains isolated sandy zones. The vertical interval with the highest hydraulic conductivity appears to be the till zone directly above bedrock. Given this fact and the topographic features of the site, in the immediate vicinity of the AEMP one would expect groundwater movement to be both vertically downward and northwards towards Fields Brook. Local movement of water would likely be controlled by the till fractures and intermittent sand lenses observed in the till. (Site Characterization Report, 1995).

The Site Characterization Report (1995) reported that 76 samples had been collected from 1986 to 1992 for background purposes. The average uranium activity concentration observed in these samples was 0.86 pCi/g with a standard deviation of 1.07 pCi/g. Each year samples were collected from approximately the same areas. The variation in uranium activity concentrations between years was greater than the variation within years, suggesting that laboratory errors dominated the variability observed. Except for one anomalous sample that yielded 8.22 pCi/g, all other samples were below 3 pCi/g.

One of the sets of data pertinent to this effort is a site wide surficial activity scan conducted using a GM on a 10 by 10 m grid. Static measurements were recorded at each grid node. Figure 2 from the Site Characterization Report (1995) summarizes the results of this scoping survey. Although soil samples were not collected as part of this effort, there was a later attempt to correlate the results from the scoping survey with results where soil activity concentrations were available. The conclusion was that a correlation could not be obtained, but that areas with activity concentrations greater than 30 pCi/g for total uranium in general had GM readings greater than 100 cpm, corrected for background. As is obvious from Figure 2, surficial activity is primarily adjacent to buildings, and follows drainage features as one moves away from buildings. In fact, some of the highest readings were encountered immediately adjacent to building foundations. While this data set provides a fair amount of information regarding the potential lateral extent of contamination, it does not assist in determining contamination depths, nor does it provide any information for areas with any significant cover (e.g., backfilled areas, areas covered with asphalt or pavement, or areas with surficial gravel).

As part of the closure process for areas deemed predominately unaffected by AEMP activities (i.e., areas A, E, and G), scans were performed and surficial samples collected. The surficial samples are of particular interest because this sampling program appears to be one of the few where relatively complete gamma spectrometry results were reported for isotopes other than just uranium. In the case of Area A and G there were specific locations where either scan data or topographical features indicated the potential for elevated levels of radionuclides. In both cases slightly elevated levels of thorium isotopes were encountered along with elevated levels of uranium in soil samples, although the Site Characterization Report (1995) attributed the thorium to sources other than licensed activities at the site (e.g., fly ash used as backfill). The potential presence of even slightly elevated levels of Th232 or Th228 is significant from the perspective of potential uranium detection limits for a NaI scanning system.

In general, there is not a significant amount of soil bore information regarding the potential vertical extent of contamination across the site. The exception to this is the CAMU area (former evaporation pond), immediately north and east of the Main Plant area. In 1988 six soil bores were completed by Eckenfelder in the former evaporation basin to depths up to 28 feet. Selected intervals from these cores were sampled and analyzed for TCE, total uranium and technetium-99. Figure 3 shows the locations of these bores, while Table 1 summarizes the results from this effort. In general, elevated levels of uranium were observed in near surface soils with concentrations decreasing with depth. Technetium-99 showed similar behavior. None of the samples yielded total uranium activity concentrations that were greater than the 30 pCi/g cleanup criteria, nor did any of the samples yield technetium-99 greater than the 65 pCi/g cleanup criteria.

In 1997 and 1998 seven additional soil bores were completed in the CAMU area by the North Carolina State University for a technology demonstration of Pre-fabricated Vertical Drains. Boring depths were in general to 30 feet. The locations of these bore holes are shown in Figure 3. Samples were collected from intervals down the length of the bores, with samples analyzed for TCE, total uranium and technetium-99. Table 2 summarizes the results from these bores. In general elevated levels of uranium, when encountered, were limited to six to eight feet in depth. There was only one bore, T3, with total uranium concentrations above the cleanup criteria. Technetium-99 contamination followed similar patterns, but with slightly deeper profiles for elevated levels. Three soil bores that had levels that exceeded the guidelines (T2, T3 and T5).

In the same time period, nine monitoring wells were installed in this area (MW500 through MW508). During installation, soils were sampled down to depths of 15 feet, and analyzed for TCE and total uranium, although in some cases soil sampling in the first several feet of soil was not conducted. The locations for these bore holes are shown in Figure 3. Table 3 summarizes the soil sampling results from these wells. One sample, from the 1 to 3 foot interval from MW502, yielded a result above total uranium cleanup guidelines.

In 2000, Earthline Technologies collected samples from 25 additional soil bores scattered across the CAMU area, down to depths of 10 to 32 feet. Figure 3 shows the locations of these soil bores. TCE and total uranium analyses were conducted for the majority of the samples. Table 4 summarizes the soil sampling results from these bores. Note that total uranium results are reported in ppm and were analyzed with an XRF. The conversion factor for natural uranium to pCi/g is 0.679, which translates the 30 pCi/g cleanup requirement to 44 ppm. For the majority of these bores, if contamination was encountered above cleanup criteria it was limited to the top 2 to 4 feet of soil. The exceptions to this were L22 and L25. In the case of L22, contamination above cleanup criteria was encountered to a depth of eight feet. In the case of L25, surficial contamination extended down to a depth of six feet, but a second layer of contamination above cleanup guidelines was encountered at a depth of 12 to 14 feet. Of the 25 soil bores in this sampling program, L25 was the closest to the Main Plant building. Contamination at this depth is not, presumably, the result of backfilling operations. It is more likely the product of contamination migration extending from beneath the footprint of the Main Plant facility or associated with buried infrastructure in this area. An example of the latter is a clay discharge drain buried at a depth of approximately 16 feet that passes along the north side of the Main Plant building.

Five monitoring wells were installed by Earthline Technologies in the CAMU area in 2000 as well, with soil sampling done during installation (wells MW800 to MW804). Figure 3 shows the location of these monitoring wells. Sampling extended down to depths of 16 to 20 feet. The resulting soil samples were analyzed for TCE and total uranium. Table 5 summarizes the soil sampling results from these wells. The wells of greatest interest are wells MW803 and MW804, which are adjacent to soil bore L25. While MW803 did encounter a surficial contamination profile similar to that observed in L25, it showed no evidence of the contaminated 12 to 14 foot interval observed in L25. MW804 was installed within the footprint of the High Bay. Although elevated uranium was observed in the two to four foot interval, there was no evidence of soil contamination above cleanup criteria for this well, nor was there evidence of the contaminated interval at depth encountered by L25.

In 2000, six soil bores were also completed either adjacent to or within the footprint of the Northwest Warehouse. Five of these soil bores had samples collected and analyzed for total uranium via XRF and/or technetium-99. Figure 4 shows the locations of the bore holes. Table 6 contains the results of the sampling work. All total uranium and technetium-99 levels observed were consistent with background. Unfortunately, with the exception of PS-2, none of the samples were from near surface soils.

Based on existing characterization data, the following conclusions can be drawn:

- scan data indicates that surficial soils surrounding the buildings are contaminated, particularly against foundation walls.
- with the exception of the CAMU area, however, there is no sampling data to indicate the depth of contamination adjacent to buildings.
- for the CAMU area, uranium contamination above cleanup guidelines, where present, was typically limited to a four foot depth, and sometimes less, with concentrations rapidly decreasing with depth.
- the interesting exception to this, soil bore T25 which was adjacent to the Main Plant structure, suggests that there may be deeper contamination migrating laterally from beneath the building or associated with buried infrastructure. However, soil samples from adjacent monitoring wells MW803 and MW804 failed to identify this deeper layer of contamination.
- data from closure activities in Areas A, E and G indicate that elevated thorium has been encountered at the site. It is not clear, however, whether one would expect to see elevated thorium for soils immediately adjacent to and below the AEMP buildings.

- extremely limited soil data from beneath the Northwest Warehouse (soil cores PS1, 2, 4, 8 and S-1A) and the Main Plant (MW804) did not identify uranium or technetium-99 contamination above cleanup guidelines.
- elevated levels of Tc99 are ubiquitous in the CAMU. The ratio of Tc99 to total uranium results, however, for those samples with both analyses was highly variable. In general, the possibility of Tc99 contamination above cleanup guidelines with uranium below its guideline increases with depth.
- the geology of the immediate vicinity would suggest that the maximum vertical extent of uranium contamination would be to bedrock, at 30 feet deep. Because of the general direction of groundwater flow, the expected direction of subsurface uranium contamination that resulted from buried sources (e.g., sumps, pits and tanks) would likely be downward and northward, with the exact distribution controlled by local features in the till.

<u>FRP 4.0</u>

The FRP 4.0 Baseline Estimate for contaminated soils associated with buildings is organized by building. The baseline estimate for buildings was developed using site process knowledge. Appendix A contains the assumptions behind the volume estimates associated with each building. Figure 4 shows the present distribution of buildings across the AEMP site. Building footprints are color coded based on whether the building is still standing, or whether the building has been removed, leaving only the slab. Table 7 presents the FRP 4.0 baseline estimate for total volumes of contaminated soil remaining at the site that require remediation. These are *in situ* volumes. Of the 71,300 cubic yards of contaminated soil identified in FRP 4.0, 27,000 cubic yards are associated with buildings. The remaining 45,300 cubic yards of soil are associated with Areas B, C, D and F. The majority of this is linked to Area B (28,900 cubic yards). Area D has been remediated and conditionally released by the ODOH. Area C is being completed and will be evaluated by ODOH for release. Figure 1 shows the relative locations of Areas B, C, D and F to the buildings.

In some cases, particularly for the Main Plant area, because of the assumed depth of contamination significant layback has been incorporated. Layback volumes, which in some cases would presumably encompass soils that are not contaminated, were included in the final FRP 4.0 Baseline Estimate. A review of the details of the FRP 4.0 Baseline Estimate was performed to disaggregate volumes associated with layback from the remainder. Based on this analysis, at least 36% of the 27,000 cubic yards is associated with potentially clean layback. The remaining 17,300 cubic yards would be presumed contaminated. The determination of whether layback is clean or contaminated is complicated by the fact that surficial soils in the vicinity of the buildings are presumed contaminated. Figure 5 shows the distribution and depth of surficial contamination taken from the Site Characterization Report (1995).

Figure 6 shows a pie chart that illustrates the relative contribution of each of the buildings to the overall volume of soil. The Main Plant area represents approximately 41% of the overall volume of soil associated with buildings in FRP 4.0, but 47% of the volume presumed contaminated in FRP 4.0. Figure 6 also shows a pie chart that identifies the relative contributions of various sources to the total contaminated volume estimate. In the FRP 4.0, there are six potential sources explicitly identified for each building: soils beneath the slabs, soils beneath the walls and foundations, soils associated with pits and sumps, soils associated with drains, soils beneath the basement in the High Bay (the "other" category in Table 1), and soils required by layback. The largest contribution to the total volume comes from layback (36%), followed by walls and slabs (34% and 20%, respectively). Surprisingly, sumps and pits only account for 5% of the total volume, as conceptualized in FRP 4.0.

Table 8 notes the most likely source of uncertainty associated with the volume estimates for each building. This uncertainty analysis is based on the assumptions in Appendix A. In some cases, such as the sump in the RF6 Butler Building Addition, contaminated depths are open to question. In other areas (e.g., the fire road adjacent to the RF6 Butler Building), the lateral extent of contamination earlier identified is unknown. In still other areas, such as the Main Plant, both depth and lateral extent is unknown. Finally, for some buildings, such as the Northwest Warehouse, the presence or absence of any contamination below the slab is an open question.

Several important conclusions arise from a review of FRP 4.0:

- In terms of the overall volume of remaining soil contamination across the site, soils beneath buildings are only 41% of the total. Given the rather sparse data sets available for the rest of surface soils upon which the estimated soil volumes in Areas B, C, D and F are based, the overall uncertainty associated with total contaminated soil volumes is probably driven as much by soils external to the buildings as by soils beneath the buildings.
- Presuming that the estimate of contaminated soils beneath the buildings is correct, of the total volume of soils estimated for buildings in FRP 4.0 more than one third may be clean layback that would not require disposal or treatment.
- Of the volume of contaminated soils identified in FRP 4.0, more than half comes from buildings other than the Main Plant.
- Of the volume of contaminated soils identified in FRP 4.0, more than half (53%) comes from soils beneath walls and foundations. Almost a third (31%) comes from underneath slabs. Only 8% of presumed contaminated soils are associated with sumps, pits and tanks.

4.0 Conceptual Models for Subsurface Soil Uranium Contamination

This discussion is primarily based on the Site Characterization Report (1995), and a memo contained in Appendix A that details the assumptions behind volume estimates in FRP 4.0. Soil contamination immediately adjacent to and beneath the footprint of AEMP buildings is assumed to have three potential sources:

- infiltration and downward leaching of surficial contamination along building foundations. The original source of this contamination would have been air deposition from building stack emissions directly on to soils immediately adjacent to buildings and building roofs, and from past operational activities (e.g., wash down of external building ventilation fans, building floors, etc.). Contamination deposited on building roofs would have been mobilized, concentrated and deposited via rain water into soils immediately adjacent to buildings. The oldest buildings and buildings with the largest roof surface area would have the greatest susceptibility to this kind of contamination.

- subsurface sources of contamination from sumps, pits, trenches and tanks within individual buildings. The primary buildings that would have been affected by this potentially are the Main Plant (High and Low Bay areas), the RF6 Butler Building, the RF6 Butler Building Addition, the Sewage Treatment Plant, the Waste Water Treatment Plant
- surficial soil contamination before building construction, backfill operations associated with building construction and maintenance activities immediately adjacent to buildings. Examples of potentially affected buildings include the NE Billet Storage Building, the Emergency Equipment Storage Building, the Office Area and Enclosed Ramp, the Northwest Warehouse, the RF3 Butler Building, the Old Incinerator, and the Outdoor Substation.

Appendix A contains detailed assumptions for each building that from the basis for the FRP 4.0 soil volume estimates. Table 8 details the primary sources of volume uncertainties for each of the buildings, with building order sorted by the percent contribution of soils associated with building to total volumes in FRP 4.0. As should be clear from this table, the highest source of uncertainty volumetrically is the percent of layback that may be contaminated, the depth of contamination assumed beneath foundations, and the contaminated soil volumes beneath slabs.

4.0 Sampling Strategies

The primary goal of the proposed data collection work for the site is to refine the volume estimates contained in FRP 4.0. The principal soil sample collection technology is a GeoProbe rig. The GeoProbe rig that will be used has the ability to complete collect both vertical cores and cores at an angle of 45 degrees. Analytical capabilities can be divided into two categories, in-field analytical capabilities for providing “real-time” information on the presence or absence of contamination in soil cores, and standard laboratory analyses. Examples of the former include a NaI probe that can be attached to the end of a GeoProbe for providing down hole gross activity information, and hand-held XRF for *in situ* direct measurement of total uranium levels. Examples of the latter include an on-site laboratory that is capable of analyzing for technetium-99, for the presence of volatile organics via a GC, and for uranium via either XRF or gamma spectroscopy.

4.1 Performance Evaluation for Portable XRF

The portable XRF unit available for this work is a Spectrace 9000. With multiple sources, this unit is capable of analyzing for a fairly wide range of metals simultaneously, including uranium.

Sample preparation requirements are minimal, other than potentially homogenizing soils. Potentially complicating factors are soil moisture content. The proposed use of the Spectrace 9000 is to screen soil core intervals for the presence of uranium above the cleanup guideline of 30 pCi/g (44 ppm). Standard operating procedures for in situ measurements using the Spectrace 9000 are based on a 10 minute measurement time.

The question is what XRF reading (T_1) should be used to identify possible total uranium contamination above the 44 ppm cleanup criteria, as measured using gamma spectroscopy. A related question is what XRF reading (T_2) should be used to identify likely total uranium contamination above 44 ppm. T_1 is important because if it can be established that it is unlikely (i.e., less than a 5% chance) to find total uranium above 44 ppm when XRF results are below T_1, then one has the means to "clear" areas of contamination concerns. On the other hand, T_2 serves the purpose of defining areas that likely (i.e., have more than a 50% probability) to be above cleanup criteria. Spectrace 9000 XRF results that lie between T_1 and T_2 represent values which are indicative of elevated radionuclide activity concentrations, but that are not definitive regarding compliance with cleanup criteria.

AEMP staff have had a significant amount of experience using the Spectrace 9000 system in the field. Based on this experience, with a 10 minute acquisition time site AEMP staff have estimated detection limits for total uranium on the order of 10 pCi/g. The site has also generated paired data sets suitable for evaluating system performance. There are 70 sample pairs in all that include both a Spectrace 9000 result, and a corresponding gamma spectroscopy result (wet). An analysis of these 70 sample pairs indicated that 48 had a Spectrace 9000 result less than 45 ppm. Of these 48, none yielded a gamma spectroscopy result greater than 30 pCi/g. There were 11 samples with a Spectrace 9000 result between 45 and 90 ppm. Of this 11, five, or 45%, yielded a gamma spectroscopy result greater than 30 pCi/g. Finally, there were another 11 samples with a Spectrace 9000 result greater than 90 ppm (ranging up to 414 ppm). Of these, seven, or 64%, yielded a gamma spectroscopy result greater than 30 pCi/g. Based on these data the recommendation is to set T_1 to 45 ppm, and T_2 to 90 ppm.

These data indicate that with the T_1 proposed, false negative rates can be expected to be extremely low (i.e., if there is total uranium contamination above 30 pCi/g present, it is highly unlikely the XRF would miss it). However, the data suggest that with the T_2 proposed, relatively high false positive rates may be observed (i.e., the XRF may flag intervals as being above acceptable levels for total uranium when this is not the case). AEMP staff have indicated that false positive performance with the Spectrace 2000 may actually be significantly better than these data suggest since improvements to the system have been implemented since these data were collected. Both the false positive and false negative rates should be monitored during data collection, and if evidence warrants, T_1 and T_2 may be modified to keep false positive and false negative rates at reasonable levels.

4.2 Performance Evaluation Data Collection for NaI System

The principal drawbacks of the portable XRF system for this characterization program are its historically high false positive rates, and its long count times (approximately 10 minutes) per measurement. There are several potential alternatives to the XRF system that are based on gamma and/or beta counting. Those currently identified that might be applicable to the AEMP's needs are a down-hole NaI sensor (gamma), a hand-held scintillator system for ex situ soil screening (gamma) and a GM for ex situ soil screenng (gamma/beta). Each of these logs activity as measured within a specified acquisition time. In this mode, gross activity measurements would be used as a proxy for the level of total uranium present. For these systems, performance evaluation data collection needs to take place to assist in evaluating their performance relative to AEMP characterization needs.

Sources contributing to the total gross activity measured by counting systems include background sources unrelated to the soil matrix in which they are used, background levels of radionuclides naturally present in the soil matrix, as well as any activity concentrations of radionculides that are present above background. To provide useful information to the site in the effort to better quantify contaminated soil volumes, several important questions need to be addressed for counting systems:

- *What is the minimum detectable level of total uranium (measured in activity concentrations) that can be reliably identified above background in subsurface soils at the AEMP site for a fixed counting period, assuming other radionuclides are at background levels?* Providing bounds on subsurface contamination volumes presumes that one is able to determine whether total uranium is above or below the required cleanup level. Consequently it is essential to know what the detection limits are for any particular counting system.
- *How does this minimum detectable level of total uranium vary with measurement time?* For repeat measurements at a single location, one would expect that detection levels for a counting system would be inversely proportional to the square root of measurement time if all of the measurement error observed in gross counts is associated with counting error. In theory one should be able to lower detection levels by increasing measurement times. In practice reality is more complicated, because background levels of radionuclides will vary across a site and with depth, and that variability contributes to the overall level of variability observed in background measurements, affecting detection limits for total uranium as well. This latter type of variability would be unaffected by measurement time..
- *What incremental gross activity level (T_1) should be used to identify possible total uranium contamination above 30 pCi/g? What incremental gross activity level (T_2) should be used to identify likely total uranium contamination above 30 pCi/g?* T_1 is important because if it can be established that it is unlikely (i.e., less than a 5% chance) to find total uranium above 30 pCi/g when gross counts are below T_1, then one has the means to "clear" areas of contamination concerns. On the other hand, T_2 serves the purpose of defining areas that likely (i.e., have more than a 50% probability) to be above cleanup criteria. Gross activities that lie between T_1 and T_2 represent activities which are

indicative of elevated radionuclide activity concentrations, but that are not definitive regarding compliance with cleanup criteria.

- *Are there other isotopes present (e.g., Th232, Ra226) at concentrations above background that could complicate interpretation of counting system results?* The presence or absence of elevated gamma emitting isotopes that belong to decay chains other than the natural uranium series is important from the perspective of interpreting gamma counting system results. If isotopes such as Th232 and Ra226 are even slightly elevated and are at relatively constant ratios with uranium across the site, the net effect would be to enhance the NaI sensor's detection limits for uranium. If isotopes such as Th232 and Ra226 are elevated but at ratios that vary significantly depending on site location, the effect would be to make gross activity triggers T_1 and T_2 conservative, presuming that those triggers were developed using results from areas where Th232 and Ra226 were at background levels.
- *Are there soil characteristics that appear to be preferentially associated with the presence or absence of contamination?* The use of visual clues for determining when contamination is likely or unlikely to occur at levels of concern becomes particularly important if detection limits for the counting systems are not sufficiently low to confidently identify total uranium at 30 pCi/g. At a site like the AEMP with relatively tight clays, one would expect uranium migration to be controlled by variations in soil types, e.g., migrating through sand layers in the clays, but sorbing to adjacent clays.
- *What depths can one reasonably expect to achieve with the GeoProbe system?* At some of the AEMP locations, particularly in the Main Plant area, uranium contamination is likely to be at a significant depth. If this is in fact the case, obtaining bounds on contaminated volumes will require being able to find the vertical extent of contamination. The tight clays and buried infrastructure in the Main Plant area both pose challenges to the ability of the GeoProbe system to reach bedrock. Knowing what depths one can reasonably expect the GeoProbe to achieve will be important in determining probing strategies.
- *What are the production rates (i.e., bore feet per day coupled with required screening analyses) that one can reasonably expect from the GeoProbe?* GeoProbe core production and core screening rates are an essential piece of information for scheduling the data collection work.

The initial deployment of the GeoProbe coupled with counting systems at the AEMP provides an opportunity to answer these questions before the technologies are used to clarify subsurface contaminated soil volumes. The steps below should assist evaluating the performance of counting system performance. These are written in the context of the NaI, but apply equally to the GM, hand-held scintillator, and any other gross gamma/beta counting system the site might want to deploy.

Determination of Gross Activity Background Levels and Variability

The first step is to determine background gross activity levels for the site and identify and quantify the principal sources of background variability as observed by the NaI system.

- Background measurements will be collected from four locations in four distinct, physically separated areas within the AEMP that are believed clean.
- Each location will consist of two pushes, the first to obtain a soil core, and the second down the same hole to obtain NaI data.
- Coring depth will be to refusal. Refusal depth should be noted in field notebooks or on soil boring logs.
- The locations where cores are obtained will be visually noted on a map of the site, with actual coordinates obtained in some appropriate manner (e.g., civil survey, GPS, or tape and chain).
- The soil core will be visually classified as to soil type (e.g., USCS, evidence of oxidation in naturally reduced glacial clays/till, "obvious" hydrocarbon or other manufacturing-liquid type staining, moisture content) in one foot intervals with this information logged in a field notebook or on soil boring logs.
- Gross activity data will also be collected in one foot intervals beginning with a depth of six inches, with the probe advanced one foot at a time and then kept stationary for a measurement.
- The first location will have measurement times of 30 seconds per depth. The second location will have measurement times of one minute per depth. The third location will have measurement times of 2 minutes per depth. The final push will have acquisition times of five minutes per depth.
- ***All measurements should be made using 30 second intervals. For measurements with total recording times greater than 30 seconds, the 30 second increments comprising the total count should be logged as well (i.e.., a five minute count will be comprised of 10 separate 30 second readings that can then be summed).***
- Gross activity results will be logged in a field notebook or on soil bore logs in a manner that allows them to be matched to soil type information.
- One composite sample should be generated from each core and submitted for on-site full suite gamma spectroscopy analysis. This sample should be obtained by a longitudinal split of the core, with the composite constructed from soils representative of the length of the core.
- Each location on the core contributing to the composite should be scanned with a GM and its reading noted in a field notebook or on a soil bore log. One interval from one selected bore should have 10 repeat GM readings.

The analysis of the data should include the following steps:

- If the top intervals show indications of impact (i.e., systematically yielded higher levels than deeper measurements), these should not be included in subsequent analyses.
- An average counts per-30-seconds should be calculated for each location using all of the data available for that location, except for measurements that might have been discarded because of concerns about the presence of elevated uranium concentrations.
- A site wide background average counts per-30-seconds should be constructed by averaging the averages from each of the four locations.

- For the location with 5 minute readings, each interval should have ten 30 second measurements available. The average and standard deviation of data for each individual interval should be calculated. The variability observed in static sequential readings should follow a Poisson distribution, i.e., the standard deviation (sometimes called the counting error) of the data set should be approximately the square root of the average number of gross counts observed. If this is not the case, then this is indicative of potential instrument issues that need to be investigated.
- The variability of measurements observed down the length of a bore, after accounting for counting errors, represents the natural vertical variability in background soils at a particular location. This can be calculated for each bore by selecting, at random, one 30 second measurement from each interval for a particular bore, and then determining the variance or total variability of the resulting data set. An estimate of vertical variability is:

  $$\sigma_{vertical} = \text{square root(total variability} - \text{counting error}^2)$$

  where the counting error associated with a 30 second measurement was determined in the last step.
- Comparing the average counts per-30-second computed for each location provides insight into how one might expect background to vary laterally across the site. This can be calculated by selecting, at random, one 30 second measurement from each interval for every bore, pooling these results, and then determining the variance or total variability (σ^2_{total}) in the resulting data set. An estimate of lateral variability is:

  $$\sigma_{lateral} = \text{square root}(\sigma^2_{total} - \sigma^2_{vertical} - \text{counting error}^2)$$
- Using the collected background data, one can calculate the incremental gross activity counts necessary for reliably identifying a particular elevated activity concentration. This analysis should be done using the 30 second measurement time data set. Assuming that the desired probability of making a false positive error is 5%, for a particular measurement time the gross activity level incremental to background which likely denotes something above background (L_c) is:

  $$L_c = 1.645 * \text{sqrt}(\sigma^2_{total})$$

  where σ^2_{total} is the total variability one observes in background gross activity measurements with a 30 second measurement time.

  Assuming that the desired probability of making a false negative error is also 5%, then the incremental gross activity that represents the detection limit (L_d) for the instrument assuming a 30 second measurement time is given by:

  $$L_d = 3.29 * \text{sqrt}(\sigma^2_{total})$$

The question for the NaI system is whether gross activity background plus L_d represents a total uranium concentration that is less than 30 pCi/g (in other words, the detection limit is less than 30 pCi/g). If this turns out to be more than 30 pCi/g, the follow-up question is how low detection limits can be dropped by reasonably increasing measurement times. The answer to the latter depends on the relative contributions of counting error, vertical variability and lateral variability to the total variability observed in background 30 second readings. One would expect that vertical variability would dominate the sources of error for 30 second gross activity measurements at background levels.

<u>Detection Limit Analysis, System Calibration, and Determination of Gross Activity Triggers T_1 and T_2</u>

The next step is to collect information that can be used to complete the detection limit analysis, develop calibration equations for the system, and determine gross activity triggers T_1 and T_2 that will be used when the system is delineating uranium contamination extent. The results from this work will determine whether the NaI has sufficient sensitivity to detect total uranium at 30 pCi/g reliably with a 30 second acquisition time (i.e., do samples with gross activity in the range of background+ L_d yield total uranium results less than 30 pCi/g?). The results should also provide the basis for estimating what the likely average incremental response (T_{30}) of the NaI would be to 30 pCi/g total uranium for a 30 second acquisition.

- Select areas where uranium concentrations are expected to be in the range of 30 pCi/g or above for total uranium over a significant depth range (e.g., more than four feet). The two likely areas for this work are adjacent to the RF3 Butler Building, where layers of highly elevated contamination have been encountered in the past, and immediately northeast of the Main Plant building, in the vicinity of the former evaporation pond, where historical bores encountered contamination to depths as great as eight feet.
- A minimum of four cores from this area should be collected, with attention focused on locations that can be expected to yield contamination at depth (e.g., four feet or more). Coring should continue to a depth of 12 feet. Additional cores may be required if the depth of contamination encountered is not sufficient to generate 20 physical soil samples that meet the needs of the performance evaluation work.
- The soil cores should be visually characterized as with the background bores, with this information logged in a field notebook or on soil bore logs.
- The resulting holes should be profiled with the NaI sensor using 30 second measurement times at one foot intervals beginning with a depth of six inches.
- At least one depth in each hole should have 10 sequential 30 second static readings. The depth selected should be the depth that has yielded a gross count closest to background plus the L_d already calculated.
- At most five samples should be selected from each of the cores and submitted to the on-site laboratory for technetium-99 and gamma spectrometry analysis. One sample should correspond to the depth where the sequential measurements were taken. The second sample should correspond to the interval with the highest NaI reading. The third sample should be taken from the first soil interval that is below background+L_c. The other two samples should be taken from intervals with gross activity readings that are in the range of background+L_c to background+L_d, if such intervals exist. If there are no samples in this range, then forego sampling. If, after four cores, twenty samples have not been

obtained, then select additional core locations and continue data collection until a total of twenty samples have been obtained.

- Collect a GM reading from each interval to be sampled as the sample is being collected. Smooth soil out over a flat surface and perform a measurement, recording the result in a field notebook or on soil bore logs.

The analysis of the data should include the following steps:

- Perform a linear regression on the resulting NaI/total uranium data sets, regressing total uranium activity concentrations as measured in the laboratory against gross activity as measured by the NaI. Use the resulting regression to estimate the incremental gross activity (T_{30}) that would be associated with 30 pCi/g. In doing this regression, no more than one data pair (i.e., combination of gross activity and gamma spec result) should be used per interval measured. For intervals where there are multiple pairs (e.g., locations where sequential NaI readings were collected), one should be selected at random.

  If T_{30} is less than L_c, then the NaI instrument is providing little information regarding the presence or absence of total uranium contamination above 30 pCi/g with a 30 second measurement time. Additional data analysis should be done to determine if increasing measurement times is likely to reduce detection limits to something below 30 pCi/g. The regression analysis should also be used to determine the uranium activity concentration that background plus L_c represents. This would represent the uranium activity concentration that the GeoProbe would be able to identify at least 50% of the time. The GeoProbe NaI can be used to assist in identifying areas that exceed this identifiable concentration, but will not be useful for "clearing" areas of uranium contamination at 30 pCi/g. In this case there will need to be heavy reliance on alternative techniques (e.g., gamma spectroscopy or XRF of core samples). T_1 and T_2 have no meaning in this context.

  If T_{30} is above L_c but below L_d, then the NaI can detect 30 pCi/g, but not reliably with a 30 second measurement time. T_1 should be set to L_c and used as the incremental gross activity trigger level for identifying intervals that pose possible uranium concerns. Additional data analysis should then be done to determine the false negative rate that using this T_1 would produce. This will be important from the perspective of confidently using NaI data to "clear" areas of concern for subsurface uranium contamination. In this case, there will need to be some soil sampling from cores to "clear" areas of concerns as work proceeds forward. T_2 should be set to T_{30}, and used as the incremental gross activity trigger level for identifying intervals that are likely to pose uranium concerns.

  If T_{30} is above L_d, then the NaI can detect 30 pCi/g reliably (i.e., the detection limit for the instrument is less than 30 pCi/g) with a 30 second count time. T_1 can be estimated as follows:

  $$T_1 = T_{30} - 1.645 * \text{square root}(\sigma^2_{total})$$

where T_{30} is the gross activity associated with total uranium at 30 pCi/g for a 30 second measurement. T_2 in this case should be set to T_{30}.

If a 30 second acquisition time does not prove to be sufficient to obtain the desired detection limits, additional data analysis can be done to determine if there is a reasonable count time that does provide the desired results. It is important to note, however, that a 30 second acquisition time is likely to provide counting errors that are smaller than the natural variability one would likely see in background gross activity, and consequently lengthening measurement times may have minimal impacts on lowering detection limits.

The end result of this work should be a table that lists T_1 and T_2 over a range of measurement times, similar to Table 9. For the sake of implementation efficiency, one would like to use the shortest measurement time that provides T_{30} greater than L_d. It may be the case that there is no "reasonable" measurement time that achieves this goal. In this case, T_1 and T_2 would be selected based on the longest "reasonable" measurement time available. It is also important to note that measurement times need not be constant during actual data collection. For volume estimation purposes, it is only necessary to determine for a particular soil interval whether it is above or below cleanup criteria. If heavy contamination is encountered, this will be readily identified with a short measurement time and there would be no need for longer counting. In any case, as gross activity measurements are made and recorded, it will be important that measurement times as well as gross activity numbers are logged.

Evaluation of the Presence of Other Elevated Radionuclides

The presence of elevated thorium isotopes has been noted for some areas of the site by past characterization and closure efforts, although the belief has been that these were isolated instances. The isotopic data generated by the gamma spectrometry analyses of potentially contaminated intervals should be reviewed to determine if the activity concentrations reported for other radionuclides (e.g., thorium-232, radium-226, etc.) fall within natural background ranges previously observed for the site.

Determination of Relationship Between Elevated Concentrations and Soil Characteristics

The data generated by this performance evaluation activity should be reviewed to determine whether there appears to be any relationship between observed soil characteristics as noted by field geologists during GeoProbe work, and either NaI gross activity results or results from laboratory analyses.

Determination of Achievable Depth Penetrations for GeoProbe Rig

The results from the background work should be reviewed, and any issues with penetration depths identified for the GeoProbe. In the best of circumstances, the GeoProbe would be able to push until bedrock is encountered, which would be expected at depths of around 30 feet.

Determination of GeoProbe Production Rates

The results from the performance evaluation work should be reviewed, and an estimated time to complete individual GeoProbe bores identified. Completion is defined in this case as the time required for a double push, once to collect a core and the second to log the initial core with the NaI sensor, along with the time to perform setup and takedown activities for specific GeoProbe locations.

Performance Validation

In addition to these performance parameters, a validation strategy needs to be in place that monitors and adjusts system use and data interpretation based on on-going data collection work. In particular, one would like to be able to show that the incremental trigger levels T_1 and T_2 for the NaI sensor are supporting correct decision-making, or, alternatively, that core screening with the XRF system is effective in identifying total uranium at 44 ppm.

In the case of the NaI system, validation begins with the performance data collected initially. For the initial set of samples with gamma spectrometry results and NaI gross activity data for the sampled interval, determine the fraction of samples with activity concentrations above 30 pCi/g that yielded incremental gross activity results below T_1. If T_1 is behaving as it should, the fraction should be very low, if not zero. If T_2 is behaving as it should, the fraction of "contaminated" samples with incremental gross activity results greater than T_2 should be greater than 50%.

As actual data collection work proceeds, validation samples from bores should be submitted for gamma spectrometry work using the following logic:

- If all NaI or XRF results for the core are below T_1, select the interval with the highest gross gamma activity/XRF reading for validation analysis if there is evidence of impact. If all XRF or NaI readings are consistent with background, select and sample the first foot of core for analysis.
- If some of the NaI or XRF results for the core are above T_1, but all are below T_2, select and sample the interval with highest result for validation analysis.
- If some but not all NaI or XRF results are above T_2, sample and analyze the first interval that is below T_1 after the last interval that is above T_2.
- If all NaI or XRF results are above T_2, then forego sampling.

A GM reading should be performed on the interval to be sampled before it is sent to the laboratory for analysis. Validation analyses should, at a minimum, include total uranium analyses via gamma spectrometry and technetium-99. The results from these samples should be matched to their gross activity readings and pooled with existing validation samples. If the fraction of samples with activity concentrations above 30 pCi/g that yielded incremental gross activity results below T_1 is not very low, T_1 should be raised until the fraction becomes negligible. T_2 should be modified so that the fraction of "contaminated" samples with incremental gross activity results greater than T_2 is approximately 50%. The validation analysis for the XRF is analogous.

4.3 GeoProbe Location Selection for Volume Estimation

Table 8 itemizes the primary sources of uncertainty for contaminated soil volumes beneath AEMP buildings, ordered by the relative contribution of each building to the total volume estimate. One can make a further distinction in these uncertainties, and that is by whether the issue is the presence or absence of contamination versus the extent of contamination that is highly likely to be there. An example of the former are soils beneath the slab of the Northwest Storage Warehouse. FRP 4.0 estimated 439 cubic yards beneath this slab, but there is no evidence that contamination beneath this slab actually exists, and in fact the little data that was collected from bores through the Northwest Storage Warehouse slab failed to encounter contamination. The bulk of layback associated with the various buildings also falls under this category. Examples of the latter are soils associated with the various tanks, sumps and pits in the High and Low Bays. In these cases at least some contamination can be expected. The question is not the presence or absence of contamination, but the amount that is present.

This analysis suggests the need for three distinctly different types of sampling goals for the buildings at AEMP:

- establish that contamination is present or absent under slabs or in layback for individual areas;
- determine the depth of contamination beneath foundations; and
- evaluate the extent of contamination (lateral and vertical) associated with deep sources.

Sampling programs to establish the presence or absence of contamination focus on areas that were included in FRP 4.0, but where there may be no contamination above cleanup goals. The purpose is to determine whether contamination does exist above cleanup goals for these areas. It is important from the AEMP's perspective to emphasize that the purpose of this sampling at this stage is not closure for these areas. It is to collect sufficient information to support the following possible decisions:

- Determine whether an area is a candidate for closure *in situ*, rather than be earmarked for excavation. In the context of MARSSIM, this is equivalent to generating information sufficient to show that an area can be classified as a Class 2 or 3 unit, allowing closure to follow Class 2 or 3 protocols.
- Determine whether layback can be presumed clean. In this case, the subsequent decisions would be whether some form of pre-excavation, during, or post-excavation data collection is necessary to identify, segregate and release layback that will be excavated, but later used as backfill.

If contamination is encountered during this type of data collection program, then there is the possibility for redirecting the program from a discovery mode to a delineation mode.

The components of this sampling would potentially include:

- biased GeoProbe cores aimed at locations believed most likely to yield contamination above cleanup guidelines, if such contamination in fact exists. The concept is simply that if one can show that contamination is not present at specific locations and depths where it would most likely exist, then one can infer that the remainder of the area is highly unlikely to be contaminated at levels that would be of concern.
- limited systematic GeoProbe coring across an area. This would be appropriate if there was no prior information that would suggest particular locations for biased sampling.
- optional judgmental GeoProbe coring to delineate contamination if encountered. In particular one may wish to investigate further subsurface contamination that was unexpected and whose existence cannot be explained with the current site conceptual model.

Sampling programs to establish the depth of contamination beneath foundations presume already that contamination is present that will require attention. The purpose of this sampling is to determine the average depth of contamination under foundations. Contaminated depths for buildings have a double implication for excavation activities. They not only drive the final depth that excavation work has to achieve during foundation removal, they also drive the layback volumes that will be required to meet these needs. At this stage, the goal of the data collection work is to provide sufficient information on probable average contamination depths, and not to provide detailed delineation of that contamination. The distinction is important, because detailed delineation requires a significantly larger investment in data collection than just obtaining a population statistic such as average depth. The components of this data collection work potentially include:

- systematic coring work along the foundations. The purpose of this coring is to determine average depths of contamination.
- optional judgmental GeoProbe coring to delineate unexpected contamination profiles, if encountered. An example of the latter would be contamination footprints that were encountered at depth and that appeared unconnected to contamination that would have resulted from leaching/infiltration downward along the foundation.

The most challenging characterization goal is the delineation of the lateral and vertical extent of contamination associated with sources at depth beneath building structures. Five buildings are potentially targets of this work because of the potential of subsurface sources. These include the High Bay, Low Bay, RF6 Building, RF6 Building Addition, and the Waste Water Treatment Plant. Of these five, High Bay sources account for more than half the volume contained in FRP 4.0 that is associated with sumps, pits, tanks and trenches. The purposes of this sampling are to:

- Identify locations of subsurface contamination beneath the buildings;
- Determine depth extent;
- Bound lateral extent.

Again, it is important to distinguish between data collection to estimate contaminated volumes (the purpose of this work), and data collection to delineate contamination (which is beyond the scope of this work). The components of the data collection work potentially include:

- biased, judgmental coring that attempts to locate where subsurface contamination is, and its deepest extent. This would be based primarily on existing information regarding the location of potential subsurface sources, combined with coring access limitations within the buildings themselves.
- biased, judgmental coring that attempts to bound contamination (vertically and laterally) that is encountered.

Given the limited number of soil core locations available to support volume estimation work, the principal goal is to obtain as much value from a volume estimation perspective as possible with the soil core locations available. The remaining discussion of building-specific characterization needs is organized by relative importance, with the most important data collection needs discussed first, followed by those of decreasing importance. The recommendation is that data collection begin towards the top of this list, and then proceed down the list of potential data collection activities until characterization resources are exhausted. Table 10 provides a master list of proposed GeoProbe locations and discusses the purpose of each location.

Main Plant (High Bay and Low Bay)

The High and Low Bays include all three data collection requirements, to investigate the presence or absence of contamination in layback and under slabs (3,100 and 600 cubic yards, respectively), the depth of contamination under foundations (5,600 cubic yards), and the lateral and vertical extent of contamination associated with potential subsurface sources (900 cubic yards). Taken together, the High and Low Bays account for just over 40% of the total soil volume associated with buildings in FRP 4.0.

The current plan for excavation in this area as quoted in the details for FRP 4.0 is to work away from the deepest point requiring excavation, with the final excavation footprint driven by logistical needs (1:1 laybacks, level working surfaces) rather than presumed contamination footprint. As identified in the details of FRP 4.0, the maximum depth of expected excavation is 17’4” underneath the press pit. The bulk of the layback identified for the High and Low Bays is layback underneath the buildings to accommodate the deep excavations expected for pits and tanks. In fact, FPR 4.0 presumed that north of the building excavation had already taken place down to a depth of 3.5 feet below existing slabs, and that along the west wall removal of the Waste Treatment Facility had resulted in an excavation depth of 6.5 feet below that slab, eliminating much of layback along the north and west walls.

Figure 7 shows a floor plan of the High and Low Bay areas with some of the major features of interest identified. Figure 8 provides an isometric view of subsurface infrastructure of this area, including the locations of footers for stem walls, tank and pit locations, and basement and trench infrastructure. What should be clear from Figure 8 is that beneath the floor area of the High and Low Bays, a significant amount of buried infrastructure is present that has an impact both on subsurface soil volume estimates and on the ability of intrusive soil coring to reach subsurface soils. Figure 9 shows another plan view of the High and Low Bay areas with the depth of footers or foundations indicated. Figure 10 shows the location of north-south cross sectional views of the High and Low Bays, while Figures 11 through 15 provide the cross-sections themselves that show potential excavation footprints. Note that these cross-sections do not completely match in detail the assumptions in FRP 4.0 (e.g., the laybacks shown here are not 1:1), but do provide a good conceptualization of what excavation work would look like.

The only available subsurface data within the High/Low Bay buildings is one monitoring well (MW 804) installed in the northwest corner of the building. The highest uranium concentrations were encountered in the 2 to 4 foot interval, but these were below the uranium cleanup guideline. Gross scan data is also available along the outside of the buildings. Gross gamma scans in general show elevated readings immediately adjacent to foundations, with levels on along the north side of the building significantly higher than levels along the south side. Along the east and west walls, readings in general increase as one moves from south to north. The presumed source of this surface contamination is runoff from roofs and wash-out activities associated with building activities. Much of the High/Low Bay area is immediately bordered by other buildings (e.g., Waste Water Treatment Plant along the west wall, NE Billet Storage Building along the east wall, the Change Area to the south, and a variety of smaller buildings along the north wall), although many of these buildings were built several years after the High and Low Bays were operational.

Data collection work for the High Bay/Low Bay area would consist of the following:

- 23 GeoProbe locations distributed along the outer/inner walls of the High/Low Bay area.
    - The purpose of these locations is to provide information about actual depths of contamination under foundations, to determine the presence or absence of contamination in layback external and internal to the building, to determine the presence or absence of contamination in subsurface slabs for those locations that fall on slabs, and to identify the potential for elevated levels at depth that may be emanating from pits and tanks underneath the High and Low Bay areas.
    - The required penetration depths for these bores will vary depending on the location, and will principally be driven by the need to clarify the presence of deep contamination for a particular location and the presumed depth of the foundation wall at that location. In general, the goal will be to attain a depth that is at least 2 feet deeper than the depth of contamination presumed in FRP 4.0. These depths may be modified based on experience gained as work progresses (e.g., if contamination under foundations is consistently found to extend deeper than what FRP 4.0 assumed).
    - The GeoProbe cores along the outer wall will be angled pushes. The offset from the outer wall will be selected so that the bore will pass directly below the outer foundation wall at a depth equal to the presumed depth of the foundation plus four feet.
    - Although FRP 4.0 identifies potential contamination under the common foundation shared by the High and Low Bays, no GeoProbe locations have been allocated to this area because it is unlikely that this contamination is actually present. Likewise, no GeoProbe locations have been allocated to the east end of

the Low Bay south wall or the Low Bay east wall because it is unlikely that contamination is present beneath these foundations.

- 8 GeoProbe locations within the High and Low Bay area that target subsurface infrastructure.
    - o The purpose of these locations is to identify the presence or absence of deep contamination associated with potential buried sources such as tanks and pits, and to determine the presence or absence of contamination beneath slabs. Their locations should be selected so that the cores have the highest probability of encountering deep contamination, if in fact it exists.
    - o Because of accessibility issues, the initial pushes will be angled to try and get beneath potential sources. The penetration depth of these bores will be to refusal.
    - o If contamination is encountered, at least one subsequent push will be performed to bound the lateral extent of the observed contamination. This subsequent push may be vertical or also angled, depending on the depth at which contamination was encountered, its vertical extent, and the orientation of presumed source, observed contamination, and launch location. The desired result from a second push would be to yield a “clean” core.
- 5 GeoProbe locations scattered within the High and Low Bay buildings that would address areas without buried infrastructure directly beneath.
    - o The purpose of these bores is to identify whether soils immediately beneath the slab are contaminated as presumed in FRP 4.0, and to assist in delineating any deep contamination encountered by the biased locations.
    - o These would be vertical bores. The presumed penetration depth is 4 feet, but this may be modified if deep contamination has been encountered by neighboring biased cores that requires further delineation.
- Additional GeoProbe cores/locations may be selected if extensive subsurface contamination is found at depth to better define its extent. These could be either vertical or angled bores, depending on the orientation of the point of accessibility relative to the position of observed contamination. In some cases, additional GeoProbe cores may be obtained at locations already open for use, using a different direction of approach than was used for previous cores.

Figure 16 shows the proposed GeoProbe locations for the High and Low Bay area. Logistical realities (e.g., accessibility, buried infrastructure, etc.) may require these locations to be shifted. An example of such a shift would be to move an external bore to an internal location where the goal is to determine contamination depths under foundations if the external location is unavailable.

RF6 Butler Building

The RF6 Butler Building includes all three data collection requirements, to investigate the presence or absence of contamination in layback and under slabs (1,500 and 700 cubic yards, respectively), the depth of contamination under foundations (600 cubic yards), and the lateral and vertical extent of contamination associated with potential subsurface sources (200 cubic yards). In addition, the RF6 Butler Building has an area slated for excavation external to the building that includes 400 cubic yards of soil. The RF6 Butler Building accounts for 13% of the total soil volume associated with buildings in FRP 4.0.

The current plan for excavation in this area as quoted in the details for FRP 4.0 is to work away from the deepest point requiring excavation, with the final excavation footprint driven by logistical needs (1:1 laybacks, level working surfaces) rather than presumed contamination footprint. As identified in the details of FRP 4.0, the maximum depth of expected excavation is 23' underneath sump "F". Excavation work for sump "F", coupled with excavation work for two other sumps, produces the bulk of the layback requirements. In addition, a significant amount of volume has been included for the excavation of 100 linear feet from the former fire road along the south side of the building, encompassing soils that extend 10 feet out from the building foundation to a depth of 10 feet.

Figure 17 shows a floor plan for the RF6 Butler Building. The RF6 Butler Building was built in 1964, and besides the Main Plant is one of the oldest buildings on site. As such, and given its position relative to the Main Plant, it is unlikely that contaminant concentrations in the soils directly beneath the slab have a significant level of contamination. There is no hard sampling data associated with the RF6 Butler Building. However, there is surface scan data around the building that identified elevated areas immediately adjacent to the foundations along the north and south walls of the building, with levels significantly higher on the north side than the south. Also, a contaminated area was encountered and partially excavated down to a depth of six feet outside the southwest overhead door. The extent of this contamination was not determined at the time. The superstructure of the RF6 Building has been removed, with only the slab and subsurface infrastructure remaining.

Data collection work for the RF6 Butler Building area would consist of the following:

- 4 GeoProbe locations south of and external to the RF6 Butler Building footprint that target excavation associated with the former Fire Road.
    - The purpose of these locations is to identify the presence or absence of subsurface contamination under the former Fire Road, and if it is present, to estimate its vertical extent.
    - These cores will be vertical. The penetration depths of these cores will be to 12 feet.
    - If significant contamination is encountered, additional cores may be collected to bound its lateral extent. Of particular concern would be the extent of contamination to the south of the building, and whether contamination extends beneath the footprint of the building.
- 3 GeoProbe locations within the RF6 Butler Building footprint that target potential subsurface sources, sumps J and G and "?".
    - The purpose of these locations is to identify the presence or absence of deep contamination associated with sumps, as well as potential contamination beneath

the slab. Their locations should be selected so that the cores have the highest probability of encountering deep contamination, if it in fact exists.
    - Because of accessibility issues, the initial pushes will be angled to try and get beneath potential sources. The presumed depths of the three sumps are 7' for "G", 16' for "F", and 3' for "?". In each case FRP4.0 assumed contamination extended four feet below the bottom of the sump. Core locations should be selected so that the probe reaches a depth of four feet below the base of the sump directly below the sump. The penetration depth of these bores will be to a depth of 13' for sump "G", 22' for sump "F", and 9' for sump "?".
    - If contamination is encountered, at least one subsequent push will be performed to bound the lateral extent of the observed contamination. This subsequent push may be vertical or also angled, depending on the depth at which contamination was encountered, its vertical extent, and the orientation of the presumed source, observed contamination, and launch location. The desired result from a second push would be to yield a "clean" core.
- 4 GeoProbe locations scattered across the RF6 Butler Building slab that address potential contamination beneath the slab.
    - The purpose of these locations is to determine the presence or absence of subsurface soil contamination beneath the slab of the RF6 building.
    - Their locations have been selected so that they, combined with the sump locations, provide relatively uniform coverage across the RF6 slab. If, for some reason, there is reason to believe that there are particular areas where subsurface soil contamination is more likely (based on past activities in the building, faults in the slab, or slab characterization data), individual core locations may be shifted to investigate these areas.
    - These cores will be vertical. The vertical penetration will be to a depth of 4 feet.
- Additional GeoProbe locations may be selected if extensive subsurface contamination is found at depth to better define its extent. These could either be vertical or angled bores, depending on the location of the observed contamination. In some cases, additional GeoProbe cores may be obtained at locations already open for use, using a direction of approach than was used for previous cores.

Figure 17 shows the proposed GeoProbe locations for the RF6 Butler Building area. Logistical realities (e.g., accessibility, buried infrastructure, etc.) may require these locations to be shifted.

<u>RF6 Butler Building Addition</u>

The RF6 Butler Building Addition includes all three data collection requirements, to investigate the presence or absence of contamination in layback and under slabs (1,100 and 400 cubic yards, respectively), the depth of contamination under foundations (500 cubic yards), and the lateral and vertical extent of contamination associated with potential subsurface sources (100 cubic yards). The RF6 Butler Building Addition accounts for 8% of the total soil volume associated with buildings in FRP 4.0.

The current plan for excavation in this area as quoted in the details for FRP 4.0 is to work away from the deepest point requiring excavation, with the final excavation footprint driven by logistical needs (1:1 laybacks, level working surfaces) rather than presumed contamination footprint. As identified in the details of FRP 4.0, the maximum depth of expected excavation is 19’ underneath the acid neutralization pit. Excavation work for the acid neutralization pit produces the bulk of the layback requirements.

Figure 18 shows a floor plan for the RF6 Butler Building Addition. The RF6 Butler Building was built in 1968. Given its age and its position relative to the Main Plant, it is unlikely that contaminant concentrations in the soils directly beneath the slab have a significant level of contamination. There is no hard sampling data associated with the RF6 Butler Building Addition. However, there is surface scan data around the building that identified elevated areas immediately adjacent to the foundations along the west wall of the building. The superstructure of the RF6 Building Addition has been removed, with only the slab and subsurface infrastructure remaining.

Data collection work for the RF6 Butler Building Addition area would consist of the following:

- One GeoProbe location within the RF6 Butler Building Addition footprint that targets potential subsurface contamination associated with the acid neutralization pit.
    - The purpose of this location is to identify the presence or absence of deep contamination associated with the acid neutralization pit, as well as potential contamination beneath the slab and in associated layback. The location should be selected so that the core has the highest probability of encountering deep contamination, if it in fact exists.
    - Because of accessibility issues, the initial push will be angled to try and get beneath the neutralization pit. FRP 4.0 assumed that the depth of the pit was 15’, and that contamination extended four feet below the bottom of the pit. The core location should be selected so that the probe reaches a depth of four feet below the base of the pit directly below the pit. The penetration depth will be to refusal.
    - If contamination is encountered, at least one subsequent push will be performed to bound the lateral extent of the observed contamination. This subsequent push may be vertical or angled, depending on the depth at which contamination was encountered, its vertical extent, and the orientation of the presumed source, observed contamination, and launch location. The desired result from a second push would be to yield a “clean” core.
- 4 GeoProbe locations scattered across the RF6 Butler Building Addition slab that address potential contamination beneath the slab.
    - The purpose of these locations is to determine the presence or absence of subsurface soil contamination beneath the slab of the RF6 Building Addition.
    - Their locations have been selected so that they, combined with the pit core, provide relatively uniform coverage across the RF6 Addition slab. If, for some reason, there is reason to believe that there are particular areas where subsurface

    soil contamination is more likely (based on past activities in the building, faults in the slab, or slab characterization data), individual core locations may be shifted to investigate these areas.
  - These cores will be vertical. The vertical penetration will be to a depth of 4 feet.
- Additional GeoProbe locations may be selected if extensive subsurface contamination is found at depth beneath the neutralization pit to better define its extent. These could either be vertical or angled bores, depending on the location of the observed contamination. In some cases, additional GeoProbe cores may be obtained at locations already open for use, using a different direction of approach than was used for previous cores.

Figure 18 shows the proposed GeoProbe locations for the RF6 Butler Building Addition area. Logistical realities (e.g., accessibility, buried infrastructure, etc.) may require these locations to be shifted.

Northwest Storage Warehouse

The principal concerns for the Northwest Storage Warehouse are to investigate the presence or absence of contamination in layback and under slabs (300 and 500 cubic yards, respectively), and the depth of contamination under foundations (200 cubic yards). The Northwest Storage Warehouse accounts for 4% of the total soil volume associated with buildings in FRP 4.0. In addition, an area directly east of the Northwest Storage Warehouse has been proposed as the location for a 40'x50' HEPA stack, and there are open questions about the vertical extent of contamination beneath this proposed building.

Figure 19 shows a floor plan for the Northwest Storage Warehouse, as well as the proposed location for the HEPA stack. The Northwest Storage Warehouse was built in 1984. At the time, a significant volume of clean fill was placed over existing soils that may have been contaminated (estimated depth of fill is 4 feet). Limited coring in the northwest section of the building failed to encounter contamination at depth. However, there is surface scan data around the building that identified isolated elevated areas immediately adjacent to the foundations along the western and eastern walls of the building. The superstructure of the Northwest Storage Warehouse has been removed, with only the slab and subsurface infrastructure remaining.

Data collection work for the Northwest Storage Warehouse area would consist of the following:

- 6 GeoProbe locations scattered across the Northwest Storage Warehouse slab that address potential contamination beneath the slab.
  - The purpose of these locations is to determine the presence or absence of subsurface soil contamination beneath the slab of the Northwest Storage Warehouse, particularly below the depth of the backfill.
  - Their locations have been selected so that they provide relatively uniform coverage across the Northwest Storage Warehouse slab. If, for some reason, there is reason to believe that there are particular areas where subsurface soil contamination is more likely (based on past activities in the building, faults in the

slab, or slab characterization data), individual core locations may be shifted to investigate these areas.
    - These cores will be vertical. The vertical penetration will be to a depth of 8 feet.
- 5 GeoProbe locations scattered across the proposed location of the HEPA Stack that address potential subsurface contamination beneath this area.
    - The purpose of these locations is to determine the presence or absence of subsurface soil contamination beneath the proposed location for the HEPA Stack.
    - Their locations have been selected so that they provide relatively uniform coverage across the proposed HEPA Stack area.
    - These cores will be vertical. The vertical penetration will be to a depth of 4 feet.

Figure 19 shows the proposed GeoProbe locations for the Northwest Storage Warehouse area. Logistical realities (e.g., accessibility, buried infrastructure, etc.) may require these locations to be shifted.

RF3 Butler Building

The principal concerns for the RF3 Butler Building are to investigate the presence or absence of contamination in layback and under slabs (200 and 500 cubic yards, respectively), and the depth of contamination under foundations (300 cubic yards). The RF3 Butler Building accounts for 4% of the total soil volume associated with buildings in FRP 4.0.

Figure 20 shows the location of the RF3 Butler Building. The RF3 Butler Building was built in 1962. There is no subsurface sample information available for this area. However, remediation work in adjacent Area D uncovered high levels of uranium contamination that required excavation to a depth of eight feet. In addition, surface scan data around the building indicated significant surface contamination along the foundations of the building. The supaerstructure of the RF3 Butler Building has been removed, with only the slab and subsurface infrastructure remaining. FRP 4.0 assumed that soils beneath the slab were contaminated to a depth of 6 feet, and that excavation would be required for soils under foundations to a depth of 4 feet, and for four feet out from the foundations.

Data collection work for the RF6 Butler Building area would consist of the following:

- 4 GeoProbe locations scattered across the RF6 Butler Building slab that address the depth of contamination beneath the slab.
    - The purpose of these locations is to determine the depth of subsurface soil contamination beneath the slab of the RF6 Butler Building.
    - Their locations have been selected so that they provide relatively uniform coverage across the RF6 Butler Building. If, for some reason, there is reason to believe that there are particular areas where subsurface soil contamination is more likely (based on past activities in the building, faults in the slab, or slab characterization data), individual core locations may be shifted to investigate these areas.

    - These cores will be vertical. The vertical penetration will be to a depth of 8 feet.
- 6 GeoProbe locations external to the RF3 Butler Building that target the foundations of the building as well as external layback.
    - The purpose of these locations is to determine the presence or absence of subsurface soil contamination beneath the foundations of the RF3 Butler Building, and in the external layback associated with the foundations.
    - Their locations have been selected so that they provide relatively uniform coverage around the foundation of the RF6 Butler Building.
    - These cores will be slant. The vertical penetration will be to a depth of 9 feet. The core location should be selected so that the probe reaches a depth of four feet below the base of the foundation directly below the foundation.

Figure 20 shows the proposed GeoProbe locations for the RF3 Butler Building area. Logistical realities (e.g., accessibility, buried infrastructure, etc.) may require these locations to be shifted.

Northeast Warehouse

The principal concern for the Northeast Warehouse is to investigate the average depth of contamination under the slab, which represents 600 cubic yards of potentially contaminated soil. The Northeast Warehouse accounts for 3% of the total soil volume associated with buildings in FRP 4.0.

Figure 20 shows the location of the Northeast Warehouse. The Northeast Warehouse was built in 1984. Because of its relatively young age and position next to the Main Plant area, the assumption is that soils beneath the slab are contaminated. There is no subsurface sample information available for this area. FRP 4.0 assumed that soils beneath the slab were contaminated to a depth of 3 feet.

Data collection work for the Northeast Warehouse area would consist of the following:

- 6 GeoProbe locations scattered across the Northeast Warehouse slab that address the depth of contamination beneath the slab.
    - The purpose of these locations is to determine the average depth of subsurface soil contamination beneath the slab of the Northeast Warehouse.
    - Their locations have been selected so that they provide relatively uniform coverage across the RF6 Butler Building.
    - These cores will be vertical. The vertical penetration will be to a depth of 5 feet.

Figure 20 shows the proposed GeoProbe locations for the Northeast Warehouse area. Logistical realities (e.g., accessibility, buried infrastructure, etc.) may require these locations to be shifted.

[similar analysis for other buildings/areas to follow]

4.4 Sampling Protocols

Data collection along GeoProbe cores will use the following protocols:

- For each retrieved core, the following information should be recorded for each one foot interval: soil core recovery (if an issue), soil type, estimated moisture content, visual anomalies, NaI gross readings (if available), NaI measurement time (if available), Hnu results (if available), GM results (if available), and XRF results for barium, lead, cadmium and total uranium (if available), as well as whether that interval was sampled for laboratory analyses and the identifier for the sample collected.
    - Soil type classification will follow the USCS.
    - Soil moisture will be recorded as either dry, damp, or saturated.
    - NaI readings will be collected using a minimum 30 second count time per interval, with the probe centered in the interval.
    - Direct XRF readings of core soils will be 10 minutes in duration. If XRF is used, readings should begin from the *bottom* of the core. If this reading yields a result greater than T_2, (an indication that coring did not bound the vertical extent of contamination), then an attempt should be made to continue coring down that hole for another four foot interval.
    - If performance evaluation data indicates that an alternative screening technology may be used (e.g., GM or hand-held scintillator) as a partial or complete substitute for the XRF or NaI probe, then these data should be noted as well.
- Physical samples will be selected for laboratory radionuclide analysis (gamma spectroscopy and technetium-99) based on the following logic:
    - if all NaI and XRF results are below T_1, then ***one sample*** will be collected for analysis. This sample will either be collected from the interval with the highest elevated measurements, if there is evidence of impact, or it will be representative of the upper one foot of material cored if all measurements are consistent with background.
    - if there are at least some NaI or XRF results greater than T_1 but all less than T_2, then ***one sample*** will be collected for analysis. This sample will be collected from the interval with the highest elevated measurement.
    - if there are one or more intervals with either NaI or XRF results greater than T_2, then ***two samples*** will be collected from the core. The first will be representative of the deepest interval with such a result. The second will be from the next deepest interval that yielded a result less than T_1.
    - if all intervals yield NaI or XRF results greater than T_2, then sample the last (or deepest) interval retrieved.
    - if the portable XRF unit is not used to screen soil cores, then samples submitted to the laboratory for analysis should also undergo XRF laboratory analysis for metals.
- Physical samples may also be collected for TCLP analysis if Spectrace 9000 results for cadmium, lead or chromium are indicative of potential TCLP concerns.
- Physical samples may also be collected for laboratory GC analysis for the presence of volatile organics based on the results from an Hnu screen. If Hnu screens of core

intervals yield elevated results for one or more interval, the interval with the highest Hnu reading will be sampled.

Soil cores should be retained in a manner that allows additional samples and/or direct measurements to be conducted if necessary. Potential reasons for obtaining additional samples and/or direct measurements include the following:

- If total uranium contamination above 30 pCi/g or technetium-99 contamination above 65 pCi/g remains unbounded vertically (i.e., the deepest interval sampled and analyzed yields results above clean-up goals), the next deepest interval from the offending core should be sampled and analyzed. This process should continue iteratively until results for total uranium and technetium-99 are below their respective cleanup guidelines.
- If the screening measurement yields a result greater than T_2, but a sample from the same interval fails to identify total uranium or technetium-99 above their respective cleanup standards, then the next shallowest interval from the offending core should be sampled and analyzed. This process should continue iteratively until either an interval is identified with sample results above cleanup guidelines, or the core is cleared off contamination concerns.

5.0 Deliverables

For each GeoProbe core, the following information should be provided:

- Core name that uniquely identifies it.
- Location of the core, in units suitable for recovering the location if required.
- Date of coring.
- Bearing of the core, if collected at an angle.
- Length of core at refusal, and an estimate of depth if an angled core.
- Estimate of the x/y location of core termination, if an angled core.
- Bore logs that include soil core recovery (if an issue), soil type, estimated moisture content, visual anomalies, NaI gross readings (if available), NaI measurement time (if available), Hnu results (if available), GM results (if available), and XRF results for barium, cadmium, lead and total uranium (if available) for each one foot interval, as well as whether that interval was sampled for laboratory analyses, along with the identifier for the sample.

For each soil sample submitted for laboratory analysis, the following information should be provided:

- Unique core name from which the sample was taken, the interval that sample was taken from, and the estimated x and y location and depth (if from an angled core).
- Sample name that uniquely identifies it.
- Date of sampling.
- Purpose of the sample.
- Analyses requested.

For each laboratory analysis performed, the following information should be provided:

- Unique sample name to which the result applies.
- Date of the analysis.
- Laboratory identifier.
- Laboratory technique used.
- Analyte name.
- Analyte result.
- Analyte units.
- Detection limits.
- Error estimates, if applicable.
- Appropriate qualifiers.

Table 1 Results from 1988 Soil Core Work in CAMU Area

SOURCE - Eckenfelder, Inc., Aug. 1988, RFI Equivalency Document

Sample ID	***Location***	***Depth (ft.)***	***TCE (mg/Kg)***	***U (pCi/g)***	***Tc99 (pCi/g)***
SB1-1	SB-1	0-2		13.5	6.11
SB 1-3		4-6	20.8		
SB 1-5		8-10		2.8	1.32
SB 1-7		12-14	2.0		
SB2-1	SB-2	0-2		4.2	6.62
SB 2-3		4-6	1.5		
SB 2-8		14-16	167.0		
SB 2-14		26-28	8.3	2.2	0.3
SB3-1	SB-3	0-2		6.0	1.52
SB 3-3		4-6	1.5		
SB 3-6		10-12	0.9		
SB3-7		12-14		8.1	0.59
SB 3-9		16-18	0.8		
SB 3-11		20-22	ND		
SB4-1	SB-4	0-2		9.2	3.24
SB 4-4		6-8	0.5		
SB4-7		12-14		1.4	8.3
SB 4-9		16-18	11.8		
SB 4-10		18-20	0.5		
SB5-1	SB-5	0-2		0.6	0.74
SB 5-4		6-8	ND		
SB5-5		8-10		3.8	< 0.3
SB 5-9		16-18	ND		
SB5-12		22-24		0.8	< 0.3
SB6-1	SB-6	0-2		20.2	1.88
SB 6-4		6-8	ND		
SB 6-9		16-18	ND		
SB6-12		22-24		0.5	< 0.3

Table 2 Soil Bore Results from NCSU Study

SOURCE - NCSU (Wick Drain Project), 7/97,6/98 and 9/98					
Sample ID	***Location***	***Depth (ft.)***	***TCE (mg/Kg)***	***U (pCi/g)***	***Tc99 (pCi/g)***
BH-1-(1')	Borehole 1	1	0.006		
BH-1-(2.5')		2.5	0.2		
BH-1-(5')		5	2.1		
BH-1-(7.5')		7.5	0.11		
BH-1-(10')		10	0.003		
BH-1-(12.5')		12.5	0.002		
BH-1-(15')		15	0.006		
BH-1-(20')		20	0.006		
BH-2-(2.5')	Borehole 2	2.5	0.56		
BH-2-(7')		7	0.004		
BH-2-(10')		10	0.006		
BH-2-(15')		15	0.002		
BH-2-(20')		20	0.006		
980630201	T-1	2-4	0.38	3.7	3.7
980630202		4-6	14	2.2	1.3
980630203		6-8	46	2.7	2.9
980630204		8-10	13	2.6	3.9
980630205		10-12	8.7	2.2	ND
980630206		15-17	0.037	2.4	0.1
980630207		20-22	0.057	2.8	0.1
980630208		25-27	ND	3.7	ND
980630209		30-32	ND	2.4	ND

Table 2 (cont) Soil Bore Results from NCSU Study

Sample ID	Location	Depth (ft.)	TCE (mg/Kg)	U (pCi/g)	Tc99 (pCi/g)
980630210	T-2	2-4	6.1	3.5	12.1
980630211		4-6	15	14.2	15
980630212		6-8	18	2.4	70.8
980630213		8-10	0.14	2.1	25.3
980630214		10-12	0.063	2.3	0.9
980630215		15-17	0.067	1.6	0.2
980630216		20-22	0.17	2	0.3
980630217		25-27	0.16	2.1	ND
980630218		28-30	0.14	3.4	0.1
980630219	T-3	2-4	0.8	141	69.7
980630220		4-6	85	58.8	518
980630221		6-8	170	11.6	88.1
980630222		8-10	310	2	156
980630223		10-12	9.2	1.8	3.3
980630224		15-17	77	1.7	1.4
980630225		20-22	3.7	1.7	0.1
980630226		25-27	0.12	0.7	1.7
980630227		28-30	0.033	1.7	0.2
980701201	T-4	2-4	0.009	29.8	18.5
980701202		4-6	0.013	5.9	0.4
980701203		8-10	4.8	2	0.5
980701204		10-12	0.079	1.3	0.5
980701206		15-17	ND	1.6	0.2
980701207		20-22	ND	1.5	0.2
980701208		25-27	ND	1.4	0.2
980701209		28-30	0.008	1.5	0.1
980701210	T-5	2-4	0.008	11	2.1
980701211		4-6	0.016	2	3.9
980701213		10-12	3.1	1.4	350
980701214		15-17	31	2.8	13.9
980701215		20-22	ND	1.6	0.2
980701216		25-27	0.023		
980701217		28-30	ND		

Table 3 Soil Sample Results from Monitoring Wells MW500 through MW508

Sample ID	Location	Depth (ft.)	TCE (mg/Kg)	U (pCi/g)
980916210	MW500 (N9)	9-10	4.657	<4.8
980916211		14-15	3.989	20.8
980916207	MW501 (N8)	4-5	30.82	22
980916208		9-10	31.13	16.2
980916209		14-15	51.83	10.2
980914202	MW502 (N4)	1-3	0.508	29.4
980914203		3-5	4.733	29.8
980914204		5-7	2.23	<2.8
980914205		7-9	5.515	19
980914206		9-11	0.0394	4.9
980914207		11-13	0.603	6.6
980914208		13-15	0.0019	4.4
980914209	MW503 (N3)	1-3	0.0655	170.7
980914210		3-5	0.608	36.1
980914211		5-7	0.619	36
980914212		7-9	117.82	12.7
980914213		9-11	81.29	15.3
980914214		11-13	69.62	7.1
980914215		13-15	81.88	3.7
980916202	MW504 (N7)	4-5	36.65	2.9
980916204		9-10	50.07	32.4
980916205		14-15	10.08	33.9
980914216	MW505 (N5)	1-3	10.55	65
980914217		3-5	31.58	12.4
980914218		5-7	37.26	6.9
980914219		7-9	83.14	<1.8
980914220		9-11	54.54	8.5
980914221		11-13	54.09	6.4
980914223		13-15	67.22	9.6
980915202	MW506 (N1)	1-3	0.061	21.3
980915203		3-5	4.328	18
980915204		5-7	0.948	53.7
980915205		7-9	4.284	19.6
980915206		9-11	48.73	4
980915207		11-13	63.27	7
980915208		13-15	0.383	<4.1
980914225	MW507 (N2)	7-9	56.25	37.5
980914226		9-11	88.33	6.3
980914227		11-13	2.85	8.4
980914228		13-15	40.65	8.6
980915209	MW508 (N6)	4-5	3.279	14.9
980915210		9-10	0.92	24.4
980915211		14-15	0.24	14.3

Table 4 Results from Earthline Soil Bores in CAMU Area

Location	**Sample number**	**Depth (ft.)**	**Uranium (ppm)**	**Tc 99 (pCi/g)**	Uncertainty %	**TCE (ug/Kg)**	reporting limit	**DCE (ug/Kg)**	**VC (ug/Kg)**
L 1	20000629840	0-2.0	83.949	32.1	15				
L 1	20000629841	2.0-4.0	6.801	35.9	14	12,300	50	ND	83
L 1	20000629842	4.0-6.0	31.444	70.2	13	63,100	500	ND	41
L 1	20000629843	6.0-8.0	24.611	69.2	14	769,000	2000	319	22
L 1	20000629844	8.0-10.0	13.02	53	13	1,620,000	5000	309	81
L 1	20000629845	10.0-12.0	6.463	<4.8		350,000	1000	598	95
L 1	Tc 99 duplicate	10.0-12.0		<5.0		*			
L 1	20000629846	12.0-14.0	4.779	<5.0		107,000	1000	41	89
L 1	20000629847	14.0-16.0	ND	8.2	23	1,170	10	53	39
L 1	20000629848	16.0-18.0	1.202	<5.0		27,600	100	155	26
L 1	20000629849	18.0-20.0	4.917	<4.90		93,300	500	206	
L 1	20000711831	20.0-22.0	3.828	4		886	5	ND	
L 1	20000711830	22.0-24.0	2.497	2.7		662	5	ND	
L 1	20000628851	24.0-26.0				238	5	ND	
L 1	20000628852	26.0-28.0				70	5	ND	
L 1	20000628853	28.0-30.0				230	5	ND	
L 1	20000628854	30.0-32.0				97	5	ND	
L 10	20000713829	0-2.0	42.917	20					
L 10	20000713830	2.0-4.0	1.461						
L 11	20000713831	0-2.0	59.745	11		*			
L 11	20000713832	2.0-4.0	25.864	10		229	5	ND	
L 11	20000713833	4.0-6.0	10.197	10		3050	10	8	
L 11	20000713834	6.0-8.0	2.892	8		2410	50	ND	
L 11	20000705852	6.0- 8.0	TCE dup			1950	50		
L 11	20000713835	8.0-10.0	30.86	9.8		ND	5	ND	
L 11	20000713836	10.0-12.0	ND			ND	5	ND	
L 11	20000713837	12.0-14.0	2.848			ND	5	ND	
L 11	20000713838	14.0-16.0	2.898			ND	5	ND	
L 11	20000713839	14.0-16.0	4.176			Tc 99 & U dup			

Table 4 (cont.) Results from Earthline Soil Bores in CAMU Area

Location	Sample number	Depth (ft.)	Uranium (ppm)	Tc 99 (pCi/g)	Uncertainty %	TCE (ug/Kg)	reporting limit	DCE (ug/Kg)	VC (ug/Kg)
L 12	20000713840	0-2.0	262.699	19		*			
L 12	20000713841	2.0-4.0	7.455	8.8		1910	5	111	
L 12	20000713842	4.0-6.0	4.367	7.4		19700	5	37	
L 12	20000714829	6.0-8.0	ND			877	5	ND	
L 12	20000713843	8.0-10.0	4.855	34		272	5	ND	
L 12	20000711844	8.0-10.0	TCE dup			7	5	ND	
L 12	20000713844	10.0-12.0	1.269			ND	5	ND	
L 12	20000713845	10.0-12.0	1.146						
L 12	20000713846	12.0-14.0	4.034			ND	100	ND	
L 12	20000713847	14.0-16.0	5.894			ND	500	ND	
L 13	20000713848	0-2.0	29.838	9.2		*			
L 13	20000713849	2.0-4.0	15.197			*		ND	
L 14	20000713850	0-2.0	9.226	18		*			
L 14	20000713851	2.0-4.0	2.879	16		133	2000	12	
L 14	20000713852	4.0-6.0	12.019	9.2		2660	500	16	
L 14	20000713853	6.0-8.0	3.991	12		8220	2000	ND	
L 14	20000711851	6.0-8.0	TCE dup			18500	500	ND	
L 14	20000713854	8.0-10.0	8.437	5.6		471	5	ND	
L 14	20000713855	8.0-10.0	3.787	7.1					
L 15	20000714820	0-2.0	29.895	28		*			
L 15	20000714821	2.0-4.0	18.296			1820	5	48	
L 15	20000714822	4.0-6.0	15.628			2830	10	17	
L 15	20000714823	6.0-8.0	2.052			36	10	ND	
L 15	20000714824	6.0-8.0	12.729						
L 15	20000714825	8.0-10.0	6.127			ND	5	ND	
L 15	20000711858	8.0-10.0	TCE dup			139	5	ND	
L 16	20000714826	2.0-4.0	75.078	35					
L 17	20000714827	0-2.0	7.846	5.8		*			
L 17	20000714828	2.0-4.0	2.959			ND	5	ND	
L 17	20000705890	4.0-6.0				ND	5	ND	
L 17	20000714830	6.0-8.0	ND			ND	5	ND	
L 17	20000714831	8.0-10.0	3.18			ND	5	ND	

Table 4 (cont.) Results from Earthline Soil Bores in CAMU Area

Location	**Sample number**	**Depth (ft.)**	**Uranium (ppm)**	**Tc 99 (pCi/g)**	Uncertainty %	**TCE (ug/Kg)**	reporting limit	**DCE (ug/Kg)**	**VC (ug/Kg)**
L 18	20000714832	0-2.0	26.039	45		*			
L 18	20000714833	2.0-4.0	2.359			ND	5	ND	
L 18	20000714834	4.0-6.0	9.734			ND	5	ND	
L 18	20000714835	6.0-8.0	7.02			ND	5	ND	
L 18	20000714836	6.0-8.0	9.252			ND	5	ND	
L 18	20000714837	8.0-10.0	4.989			ND	5	ND	
L 19	20000714838	0-2.0	40.893	30		*			
L 19	20000714839	2.0-4.0	10.323			20		ND	
L 19	20000714840	4.0-6.0	5.566			ND		ND	
L 19	20000714841	6.0-8.0	10.17			ND		ND	
L 19	20000714842	6.0-8.0	7.732						
L 19	20000714843	8.0-10.0	7.587			ND		ND	
L 19	20000711868	8.0-10.0	TCE dup			ND		ND	
L 2	20000711820	0-2.0	27.429	5.6		*			
L 2	20000711821	2.0-4.0	21.829	4		ND	5	ND	
L 2	20000711822	4.0-6.0	11.466	-2.4		ND	5	ND	
L 2	20000711823	6.0-8.0	5.996	2.7		ND	5	ND	
L 2	20000711824	8.0-10.0	3.932	4.9		ND	5	ND	
L 2	20000711825	10.0-12.0	12.77	5.8		ND	5	ND	
L 2	20000711826	12.0-14.0	7.055	5		ND	5	ND	
L 2	20000711827	14.0-16.0	5.109	7.7		ND	5	ND	
L 2	20000711828	16.0-18.0	7.118	5.3		ND	5	ND	
L 2	20000711829	18.0-20.0	ND	4.2		ND	5	ND	
L 20	20000714844	2.0-4.0	222.355	27					
L 21	20000803800	0-2.0	123.51	67		*			
L 21	20000803801	2.0-4.0	7.363	2		ND			
L 21	20000803802	4.0-6.0	4.466	20		138			
L 21	20000803803	6.0-8.0	6.238	8		209			
L 21	20000803804	6.0-8.0 D	2.946	14		107			
L 21	20000803805	8.0-10.0	6.955			ND			
L 21	20000803806	10.0-12.0	ND			ND			
L 21	20000803807	12.0-14.0	ND			ND			
L 21	20000803808	14.0-16.0	5.801			ND			

Table 4 (cont.) Results from Earthline Soil Bores in CAMU Area

Location	Sample number	Depth (ft.)	Uranium (ppm)	Tc 99 (pCi/g)	Uncertainty %	TCE (ug/Kg)	reporting limit	DCE (ug/Kg)	VC (ug/Kg)
L 22	20000803811	0-2.0	49.751	81		*			
L 22	20000803812	4.0-6.0	72.199	48		1930			
L 22	20000803813	6.0-8.0	78.069	15		1880			
L 22	20000803814	8.0-10.0	10.771			1520			
L 22	20000803815	8.0-10.0D	8.234			1850			
L 22	20000803816	10.0-12.0	36.996			3440			
L 22	20000803817	12.0-14.0	7.145			810			
L 22	20000803818	14.0-16.0	2.635			18			
L 23	20000803821	0-2.0	20.367	8.3		*			
L 23	20000803822	2.0-4.0	3.882			35		52	
L 23	20000803823	4.0-6.0	5.404			ND		9	
L 23	20000803824	6.0-8.0	8.613			ND			
L 23	20000803825	6.0-8.0D	8.043			ND			
L 23	20000803826	8.0-10.0	11.65			ND			
L 23	20000803827	10.0-12.0	ND			ND			
L 23	20000803828	12.0-14.0	1.999			ND			
L 23	20000803829	14.0-16.0	8.119			ND			
L 23	20000727878	16.0-18.0	*			ND			
L 23	20000727879	18.0-20.0	*			ND			
L 23	20000727880	20.0-22.0	*			ND			
L 23	20000727881	22.0-24.0	*			ND			
L 23	20000727882	24.0-26.0	*			ND			
L 23	20000727883	26.0-28.0	*			ND			
L 23	20000727884	28.0-30.0	*			ND			
L 23	20000727885	30.0-32.0	*			ND			
L 23	20000727886	32.0-34.0	*			ND			
L 24	20000803830	0-2.0	44.667	21		*			
L 24	20000803831	2.0-4.0	22.03	19		ND		295	
L 24	20000803832	6.0-8.0	0.67	4.6		ND			
L 24	20000803833	8.0-10.0	5.365			ND			
L 24	20000803834	8.0-10.0D	2.029			ND			
L 24	20000803835	10.0-12.0	8.696			ND			

Table 4 (cont.) Results from Earthline Soil Bores in CAMU Area

Location	Sample number	Depth (ft.)	Uranium (ppm)	Tc 99 (pCi/g)	Uncertainty %	TCE (ug/Kg)	reporting limit	DCE (ug/Kg)	VC (ug/Kg)
L 25	20000803840	0-2.0	4980.298	8.2		*			
L 25	20000803841	2.0-4.0	912.523	4.9		466			
L 25	20000803842	4.0-6.0	331.568	2.4		ND		42	
L 25	20000803843	6.0-8.0	16.498	2.5		ND			
L 25	20000803844	8.0-10.0	4.924			ND			
L 25	20000803845	8.0-10.0D	ND			ND			
L 25	20000803846	10.0-12.0	7.407			ND			
L 25	20000803847	12.0-14.0	155.531			ND			
L 25	20000803848	14.0-16.0	ND			ND			
L 3	20000711832	0-2.0	150.177	17		*			
L 3	20000711833	2.0-4.0	42.393	7.2		ND	5	ND	
L 3	20000711834	4.0-6.0	10.766	3.5		ND	5	ND	
L 3	20000711835	6.0-8.0	5.765	7.2		ND	5	ND	
L 3	20000711836	8.0-10.0	3.634	8.2		ND	5	ND	
L 3	20000711837	10.0-12.0	7.365	7.3		ND	5	ND	
L 3	20000711838	12.0-14.0	8.049	8.1		ND	5	ND	
L 3	20000711839	14.0-16.0	7.989	6.7		ND	5	ND	
L 3	20000711840	16.0-18.0	6.154	2.7		ND	5	ND	
L 3	20000711841	18.0-20.0	6.444	0.82		ND	5	ND	
L 3	20000627858	20.0-22.0				ND	5	ND	
L 3	20000627859	22.0-24.0				ND	5	ND	
L 4	20000711843	0-2.0	28.871	-0.07		*			
L 4	20000711844	2.0-4.0	17.47	5		ND	5	ND	
L 4	20000711842	4.0-6.0	22.603	2.7		ND	5	ND	
L 4	20000711845	6.0-8.0	16.456	1.8		ND	5	ND	
L 4	20000711846	8.0-10.0	12.08	2.4		ND	5	ND	
L 4	20000711847	10.0-12.0	9.172	3.9		ND	5	ND	
L 4	20000711848	12.0-14.0	5.469	3.7		ND	5	ND	
L 4	20000711849	14.0-16.0	4.822	3.2		ND	5	ND	
L 4	20000711850	16.0-18.0	4.401	2.9		ND	5	ND	
L 4	20000711851	18.0-20.0	ND	2.9		ND	5	ND	

Table 4 (cont.) Results from Earthline Soil Bores in CAMU Area

Location	Sample number	Depth (ft.)	Uranium (ppm)	Tc 99 (pCi/g)	Uncertainty %	TCE (ug/Kg)	reporting limit	DCE (ug/Kg)	VC (ug/Kg)
L 5	20000712820	0-2.0	56.047			*			
L 5	20000712821	2.0-4.0	185.221	5.4		ND	5	ND	
L 5	20000712822	4.0-6.0	17.043			495	5	ND	
L 5	20000712823	6.0-8.0	24.949			147	5	28	
L 5	20000712824	8.0-10.0	10.464			ND	5	16	
L 5	20000712825	10.0-12.0	6.275			ND	5	ND	
L 5	20000712826	12.0-14.0	3.572			ND	5	ND	
L 5	20000712827	14.0-16.0	10.918			239	5	ND	
L 5	20000712828	16.0-18.0	6.512			ND	5	ND	
L 5	20000712829	18.0-20.0	6.536			ND	5	ND	
L 6	20000712830	2.0-4.0	297.464			ND	5	93	
L 6	20000712831	4.0-6.0	98.558			ND	5	ND	
L 6	20000712832	6.0-8.0	6.526			ND	5	ND	
L 6	20000712833	8.0-10.0	2.426			ND	5	ND	
L 6	20000712834	10.0-12.0	33.099			ND	5	ND	
L 6	20000712835	12.0-14.0	6.182			ND	5	ND	
L 6	20000712836	14.0-16.0	36.839			ND	5	ND	
L 6	20000712837	16.0-18.0	3.631			ND	5	ND	
L 6	20000712838	18.0-20.0	6.378			ND	5	ND	
L 6	20000712839	20.0-22.0	7.758			ND	5	ND	
L 6	20000712840	22.0-24.0	5.118			ND	5	ND	
L 7	20000712841	0-2.0	406.927	40		*			
L 7	20000712842	2.0-4.0	34.329	25		1081	5	ND	
L 7	20000712843	4.0-6.0	1.975	40		7250	5	ND	
L 7	20000712844	6.0-8.0	4.722	21		9510	5	ND	
L 7	20000712845	8.0-10.0	3.678	20		11900	5	ND	
L 7	20000712846	10.0-12.0	5.476			101000	5	ND	
L 7	20000712847	12.0-14.0	2.762			51800	5	ND	
L 7	20000712848	14.0-16.0	9.533			ND	5	ND	
L 7	20000712849	16.0-18.0	6.909			ND	5	ND	
L 7	20000712850	18.0-20.0	6.346			ND	5	ND	
L 7	20000712851	20.0-22.0	10.781			168	5	ND	
L 7	20000712852	22.0-24.0	3.769			ND	5	ND	

Table 4 (cont.) Results from Earthline Soil Bores in CAMU Area

Location	**Sample number**	**Depth (ft.)**	**Uranium (ppm)**	**Tc 99 (pCi/g)**	Uncertainty %	**TCE (ug/Kg)**	reporting limit	**DCE (ug/Kg)**	**VC (ug/Kg)**
L 8	20000712853	0-2.0	0.225	6.9		*			
L 8	20000712854	2.0-4.0	ND			2340	5	ND	
L 8	20000712855	4.0-6.0	37.939			511	5	ND	
L 8	20000712856	6.0-8.0	11.68			3660	5	ND	
L 8	20000712857	8.0-10.0	12.182			1500	5	ND	
L 8	20000712858	10.0-12.0	ND			ND	5	ND	
L 8	20000712859	12.0-14.0	ND			ND	5	ND	
L 8	20000712860	14.0-16.0	5.819			ND	5	ND	
L 9	20000713820	0-2.0	263.624	64		*			
L 9	20000713821	2.0-4.0	79.738			16800	100	11	
L 9	20000713822	4.0-6.0	16.279			3220	500	11	
L 9	20000713823	4.0-6.0	53.186						
L 9	20000713824	6.0-8.0	172.845			307000	2500	25	
L 9	20000713825	8.0-10.0	77.694			755000	2500	17	
L 9	20000705844	8.0-10.0	TCE dup			835000	2500		
L 9	20000713826	10.0-12.0	39.326			332000	1000	ND	
L 9	20000713827	12.0-14.0	38.065			127000	500	ND	
L 9	20000713828	14.0-16.0	5.847			163000	500	ND	

Table 5 Soil Sample Results from MW800 to MW804

Location	Sample number	Depth (ft.)	Uranium (ppm)	Tc 99 (pCi/g)	TCE (ug/Kg)	DCE (ug/Kg)
MW 800	20000714845	0-2.0	ND		*	
MW 800	20000714846	2.0-4.0	5.639		ND	ND
MW 800	20000714847	4.0-6.0	3.812		258	ND
MW 800	20000714848	6.0-8.0	2.566		6	ND
MW 800	20000714849	8.0-10.0	5.724		305	ND
MW 800	20000714850	10.0-12.0	5.337		117	ND
MW 800	20000714851	12.0-14.0	ND		ND	ND
MW 800	20000714852	14.0-16.0	6.21	1.3	71	ND
MW 801	20000717820	0-2.0	2.558		*	
MW 801	20000717821	2.0-4.0	ND		117	ND
MW 801	20000717822	4.0-6.0	4.442	4.4	ND	ND
MW 801	20000717823	6.0-8.0	2.976	4.1	71	ND
MW 801	20000717824	8.0-10.0	9.219	3.9	ND	ND
MW 801	20000717825	10.0-12.0	2.741		ND	ND
MW 801	20000717826	12.0-14.0	2.727		ND	ND
MW 801	20000717827	14.0-16.0			ND	ND
MW 802	20000717828	0-2.0	1.59		*	
MW 802	20000717829	2.0-4.0	5.563		ND	ND
MW 802	20000717830	4.0-6.0	4.387		ND	ND
MW 802	20000717831	6.0-8.0	1.036		ND	ND
MW 802	20000717832	8.0-10.0	1.265		560	ND
MW 802	20000717833	10.0-12.0	ND		ND	ND
MW 802	20000717834	12.0-14.0	ND		ND	ND
MW 802	20000717835	14.0-16.0	8.203		ND	ND
MW 803	20000802830	0-2.0	76.169	4.2	ND	
MW 803	20000802831	2.0-4.0	64.052	3.7	ND	
MW 803	20000802832	4.0-6.0	2.557	2.6	ND	
MW 803	20000802833	6.0-8.0	ND	5	ND	
MW 803	20000802834	6.0-8.0D	5.321	3.8	ND	
MW 803	20000802835	8.0-10.0	9.298	2.2	ND	
MW 803	20000802836	10.0-12.0	1.842	2.4	ND	
MW 803	20000802837	12.0-14.0	5.119	1.6	ND	

Table 5 (cont.) Soil Sample Results from MW800 to MW804

Location	Sample number	Depth (ft.)	Uranium (ppm)	Tc 99 (pCi/g)	TCE (ug/Kg)	DCE (ug/Kg)
MW 803	20000802838	14.0-16.0	9.743	0.91	ND	
MW 803	20000802839	16.0-18.0	5.581		ND	
MW 803	20000802840	18.0-20.0	6.829		ND	
MW 804	20000802841	0-2.0	1.502	1.3	ND	
MW 804	20000802843	4.0-6.0	ND	0.63	ND	
MW 804	20000802844	6.0-8.0	3.831	2.5	ND	
MW 804	20000802845	6.0-8.0D	7.188	2	ND	
MW 804	20000802846	8.0-10.0	4.652	2.5	ND	
MW 804	20000802847	10.0-12.0	13.534	2.5	ND	
MW 804	20000802848	12.0-14.0	7.188	2	ND	
MW 804	20000802849	14.0-16.0	3.266	2	ND	
MW 804	20000802850	16.0-18.0	ND		ND	
MW 804	20000802851	18.0-20.0	3.4		ND	
MW 804	20000802842	2.0-4.0	32.77	2.8	ND	

Table 6 Soil Sample Results from Northwest Warehouse

Location	Sample	Depth	Total U (ppm)	Tc-99 (pCi/g)
PS-1	PS-1A	15'-17'	8.189	<9.4
PS-1	PS-1B	15'-17'	N.D.	
PS-1	PS-1C	15'-17'	2.858	
PS-1	PS-1D	15'-17'	N.D.	
PS-1	PS-1E	15'-17'	N.D.	
PS-1	PS-1F	15'-17'	2.544	
PS-1	PS-1G	15'-17'	N.D.	
PS-2	PS-2A	0"-3"	5.528	
PS-2	PS-2B	3"-6"	7.675	
PS-2	PS-2C	6"-9"	9.492	
PS-2	PS-2D	9"-12"	7.594	
PS-2	PS-2E	12"-15"	9.496	
PS-2		8'-9'	5.869	
PS-2		9'-10'	4.497	
PS-2		10'-11'	ND	
PS-2		11'-12'	0.528	
PS-2		12'-13'	1.684	
PS-2		13'-14'	6.443	
PS-2		15'-16'	ND	
PS-2		16'-17'	ND	
PS-2		17'-19'		<9.2
PS-2		19'-20'	ND	
PS-2		20'-21'	ND	
PS-2		28'-29'	ND	<10.4
PS-2		29'-30'	ND	
PS-2		30'-31	ND	
PS-2		31'-32'	ND	
PS-6		10'-11'	3.943	
PS-6		11'-12'	6.089	
PS-6		21'-22'	5.44	
PS-6		22'-23'	7.385	
PS-6		23'-24'	5.304	
PS-6		24'-25'	8.587	
PS-6		25'-26'	9.725	
PS-6		26'-27'	1.827	

Table 6 (cont.) Soil Sample Results from Northwest Warehouse

Location	Sample	Depth	Total U (ppm)	Tc-99 (pCi/g)
PS-8		8'-9'	19.719	
PS-8		9'-10'	13.9	
PS-8		10'-11'	17.285	
PS-8		11'-12'	15.85	
PS-8		12'-13'	12.636	
PS-8		13'-14'	N.D.	
PS-8		15'-16'	11.373	
PS-8		16'-17'	14.931	
PS-8		19'-20'	9.592	
PS-8		20'-21'	19.114	
PS-8		21'-22'	N.D.	
PS-8		22'-23'	2.569	
PS-8		28'-29'	5.576	
PS-8		29'-30'	N.D.	
PS-8		30'-31'	10.262	
PS-8		31'-32'	8.135	
PS-8	PS-8A	17'-19'	20.194	<9.2
PS-8	PS-8B	17'-19'	15.037	<9.4
PS-8	PS-8C	17'-19'	15.338	<9.8
PS-8	PS-8D	17'-19'	10.687	<10.0
PS-8	PS-8E	17'-19'	16.727	<10.0
PS-8	PS-8F	17'-19'	9.076	<9.8
PS-8	PS-8G	17'-19'	11.508	<9.4
PS-8	PS-8H	17'-19'	11.663	<9.2
S-1A		10'-11'	ND	
S-1A		11'-12'	10.455	
S-1A		12'-13'	8.743	
S-1A		13'-14'	1.089	
S-1A		17'-18'	4.56	
S-1A		18'-19'	0.9	
S-1A		19'-20'	7.512	
S-1A		20'-21'	ND	
S-1A	S-1A-A		6.288	
S-1A	S-1A-B		ND	
S-1A	S-1A-C		3.612	
S-1A	S-1A-D		5.831	
S-1A	S-1A-E		3.241	
S-1A	S-1A-F		4.177	
S-1A	S-1A-G		4.644	

Table 7 Details of FRP 4.0 Volume Estimate (cubic yards)

Location	Slab	Walls	Sumps/Pits	Drains	Other	Layback	Total
Northeast Warehouse	589	91	0	6	0	121	807
Compressor Room	22	25	0	0	0	30	77
Truck Dock	25	109	0	0	0	100	235
Emergency Equipment	6	17	0	0	0	22	45
Enclosed Truck Ramp	38	62	0	94	0	164	358
High Bay	248	3,755	805	0	853	2,102	7,762
Low Bay	382	1,891	131	0	0	976	3,380
Change Area	313	138	0	53	0	543	1,046
Enclosed Ramp	48	52	0	0	0	108	208
NW Storage Whse	493	239	6	107	0	333	1,179
Hazardous Storage Bldg.	55	33	0	0	0	45	133
RF3 Butler Bldg.	507	302	0	0	0	203	1,012
RF6 Building	706	628	184	106	367	1,474	3,465
RF6 Addition	350	499	121	20	0	1,125	2,114
Runout Table Filter Bldg.	100	0	0	0	0	3	103
Campbell Saw Filter Bldg.	84	21	0	0	0	25	130
Sewage Treatment Plant	46	706	0	0	0	759	1,511
CEI Substation	314	115	0	0	0	56	485
Waste Water Treatment Plant	434	138	177	0	0	737	1,486
Tool Crib	240	25	0	0	0	32	297
Die Head Filter Bldg.	172	35	0	0	0	52	260
Incinerator Bldg.	46	146	0	0	0	124	316
RMI Indoor Substation	51	14	0	0	0	8	72
Outdoor Substation	76	4	0	0	0	4	84
Soils Washing Bldg.	0	115	13	73	0	281	482
Site Area B	0	0	0	0	28,916	0	28,916
Site Area C	0	0	0	0	6,362	0	6,362
Site Area D	0	0	0	0	5,911	0	5,911
Site Area F	0	0	0	0	3,092	0	3,092
Building Totals:	5,344	9,161	1,437	460	853	9,793	27,048
Grand Totals:	5,344	9,161	1,437	460	45,135	9,793	71,330

Table 8 Sources of Uncertainty for Buildings in FRP 4.0

Location	% Total Volume	Sources of Soil Volume Uncertainty
High Bay	28.7	Depth of contamination under foundations and % layback contaminated.
RF6 Building	12.8	% layback contaminated and depth of contamination under slab.
Low Bay	12.5	Depth of contamination under foundations and % layback contaminated.
RF6 Addition	7.8	% layback contaminated, depth of contamination under foundations, depth under former Fire Road
Sewage Treatment Plant	5.6	% layback contaminated and depth of contamination under foundations.
Waste Water Treatment Plant	5.5	% layback contaminated and depth of contamination under slab.
NW Storage Whse	4.4	Depth of contamination under slab and % layback contaminated.
Change Area	3.9	% layback contaminated and depth of contamination under slab.
RF3 Butler Bldg.	3.7	Depth of contamination under slab and foundations.
Northeast Warehouse	3.0	Depth of contamination under slab.
CEI Substation	1.8	Depth of contamination under slab.
Soils Washing Bldg.	1.8	% layback contaminated and depth of contamination under foundations.
Enclosed Truck Ramp	1.3	% of layback contaminated.
Incinerator Bldg.	1.2	Depth of contamination under foundations and % layback contaminated.
Tool Crib	1.1	Depth of contamination under slab.
Die Head Filter Bldg.	1.0	Depth of contamination under slab.
Truck Dock	0.9	Depth of contamination under foundations.
Enclosed Ramp	0.8	% layback contaminated.
Hazardous Storage Bldg.	0.5	Depth of contamination under slab and % layback contaminated.
Campbell Saw Filter Bldg.	0.5	Depth of contamination under slab.
Runout Table Filter Bldg.	0.4	Depth of contamination under slab.
Outdoor Substation	0.3	Depth of contamination under slab.
Compressor Room	0.3	Depth of contamination under slab and foundations.
RMI Indoor Substation	0.3	Depth of contamination under slab.
Emergency Equipment	0.2	Depth of contamination under foundations.

Table 9 Incremental Gross Activity Triggers as a Function of Acquisition Time

Count Time	Background Counts	L_c	L_d	T_{30}	T_1	T_2
15 sec	1,000	74	147	50	na	na
30 sec	2,000	104	208	100	na	na
60 sec	4,000	147	294	200	147	200
2 min	8,000	208	416	400	208	400
5 min	20,000	330	660	1,000	662	1,000
10 min	40,000	466	932	2,000	1,522	2,000

Note: Values are for illustration purposes only. Counting error was assumed to be the major source of total error for these numbers. "na" stands for not applicable.

Table 10 Details of GeoProbe Core Locations

Core #	Building	Core ID	Type	Vertical Depth	Purpose/Comments
1	RF6 Bldg.	RF6-1	Vertical	12'	Fire Road.
2	RF6 Bldg.	RF6-2	Vertical	12'	Fire Road.
3	RF6 Bldg.	RF6-3	Vertical	12'	Fire Road.
4	RF6 Bldg.	RF6-4	Vertical	12'	Fire Road.
5	RF6 Bldg.	RF6-5	Slant	22'	Sump, slab, internal layback.
6	RF6 Bldg.	RF6-6	Slant	9'	Sump, slab, internal layback.
7	RF6 Bldg.	RF6-7	Slant	13'	Sump, slab, internal layback.
8	RF6 Bldg.	RF6-8	Vertical	4'	Slab.
9	RF6 Bldg.	RF6-9	Vertical	4'	Slab.
10	RF6 Bldg.	RF6-10	Vertical	4'	Slab.
11	RF6 Bldg.	RF6-11	Vertical	4'	Slab.
12	RF6 Addition	RF6A-1	Vertical	4'	Slab.
13	RF6 Addition	RF6A-2	Vertical	4'	Slab.
14	RF6 Addition	RF6A-3	Vertical	4'	Slab.
15	RF6 Addition	RF6A-4	Vertical	4'	Slab.
16	RF6 Addition	RF6A-5	Slant	To Refusal	Pit, slab, internal layback.
17	Main Plant	MP-1	Slant	12'	Foundation, slab.
18	Main Plant	MP-2	Slant	12'	Foundation, slab, external layback.
19	Main Plant	MP-3	Slant	To Refusal	Foundation, tanks, external layback.
20	Main Plant	MP-4	Slant	12'	Foundation, slab, external layback.
21	Main Plant	MP-5	Slant	12'	Foundation, external layback.
22	Main Plant	MP-6	Slant	12'	Foundation, slab, external layback.
23	Main Plant	MP-7	Slant	12'	Foundation, slab, external layback.
24	Main Plant	MP-8	Slant	12'	Foundation, slab, external layback.
25	Main Plant	MP-9	Slant	12'	Foundation, slab, external layback.
26	Main Plant	MP-10	Slant	12'	Foundation, external layback.
27	Main Plant	MP-11	Slant	12'	Foundation, external layback.
28	Main Plant	MP-12	Slant	12'	Foundation, slab, internal layback.
29	Main Plant	MP-12	Slant	12'	Foundation, slab, internal layback.
30	Main Plant	MP-14	Slant	12'	Foundation, external layback.
31	Main Plant	MP-15	Slant	12'	Foundation, external layback.
32	Main Plant	MP-16	Slant	12'	Foundation, external layback.
33	Main Plant	MP-17	Slant	12'	Foundation, external layback.
34	Main Plant	MP-18	Slant	To Refusal	Foundation, tanks, external layback.
35	Main Plant	MP-19	Slant	12'	Foundation, external layback.
36	Main Plant	MP-20	Slant	12'	Foundation, slab, internal layback.
37	Main Plant	MP-21	Slant	12'	Foundation, slab, internal layback.
38	Main Plant	MP-22	Slant	12'	Foundation, slab, internal layback.

Table 10 (cont.) Details of GeoProbe Core Locations

Core #	Building	Core ID	Type	Vertical Depth	Purpose/Comments
39	Main Plant	MP-23	Slant	12'	Foundation, slab, internal layback.
40	Main Plant	MP-24	Slant	To Refusal	Tanks, slab, internal layback.
41	Main Plant	MP-25	Slant	To Refusal	Tanks, slab, internal layback.
42	Main Plant	MP-26	Slant	To Refusal	Salt Bath Pit, slab, internal layback.
43	Main Plant	MP-27	Slant	To Refusal	Tanks, slab, internal layback.
44	Main Plant	MP-28	Slant	To Refusal	Tanks, slab, internal layback.
45	Main Plant	MP-29	Slant	To Refusal	Tanks, slab, internal layback.
46	Main Plant	MP-30	Slant	To Refusal	Press Pit, slab, internal layback.
47	Main Plant	MP-31	Slant	To Refusal	Press Pit, slab, internal layback.
48	Main Plant	MP-32	Vertical	4'	Slab.
49	Main Plant	MP-33	Vertical	4'	Slab.
50	Main Plant	MP-34	Vertical	4'	Slab.
51	Main Plant	MP-35	Vertical	4'	Slab.
52	Main Plant	MP-36	Vertical	4'	Slab.
53	NW Storage Whse	NWS-1	Vertical	8'	Slab.
54	NW Storage Whse	NWS-2	Vertical	8'	Slab.
55	NW Storage Whse	NWS-3	Vertical	8'	Slab.
56	NW Storage Whse	NWS-4	Vertical	8'	Slab.
57	NW Storage Whse	NWS-5	Vertical	8'	Slab.
58	NW Storage Whse	NWS-6	Vertical	8'	Slab.
59	NW Storage Whse	NWS-7	Vertical	4'	Slab.
60	NW Storage Whse	NWS-8	Vertical	4'	Slab.
61	NW Storage Whse	NWS-9	Vertical	4'	Slab.
62	NW Storage Whse	NWS-10	Vertical	4'	Slab.
63	NW Storage Whse	NWS-11	Vertical	4'	Slab.
64	RF3 Butler Building	RF3-1	Vertical	8'	Slab.
65	RF3 Butler Building	RF3-2	Vertical	8'	Slab.
66	RF3 Butler Building	RF3-3	Vertical	8'	Slab.
67	RF3 Butler Building	RF3-4	Vertical	8'	Slab.
68	RF3 Butler Building	RF3-5	Slant	9'	Foundation, external layback.
69	RF3 Butler Building	RF3-6	Slant	9'	Foundation, external layback.
70	RF3 Butler Building	RF3-7	Slant	9'	Foundation, external layback.
71	RF3 Butler Building	RF3-8	Slant	9'	Foundation, external layback.
72	RF3 Butler Building	RF3-9	Slant	9'	Foundation, external layback.
73	RF3 Butler Building	RF3-10	Slant	9'	Foundation, external layback.

Table 10 (cont.) Details of GeoProbe Core Locations

Core #	Building	Core ID	Type	Vertical Depth	Purpose/Comments
74	NE Warehouse	NEW-1	Vertical	5'	Slab.
75	NE Warehouse	NEW-2	Vertical	5'	Slab.
76	NE Warehouse	NEW-3	Vertical	5'	Slab.
77	NE Warehouse	NEW-4	Vertical	5'	Slab.
78	NE Warehouse	NEW-5	Vertical	5'	Slab.
79	NE Warehouse	NEW-6	Vertical	5'	Slab.

February 10, 2001

FRP 4.0 Building Soil Excavation Assumptions

On October 25, 2000, Earthline met with DOE-AB to develop a reasonable set of assumptions to use in calculating the AEMP sub-slab soil excavation quantities for the FRP 4.0 baseline estimate. The use of process knowledge is necessary due to the absence of soil sampling data. It has been estimated that a complete sampling program would cost in excess of $2 million. Since this would only increase the accuracy of the estimate, without reducing the cost of remediation, it was decided to forego sampling. FRP Rev. 0 assumed 24" of excavation under all buildings. Since we had no sample data available, DOE directed that subsequent baseline updates reduce excavation depth to 12" in order to help keep total project cost within available funding. As part of Earthline's direction from DOE-AB, FRP 4.0 will be based on the best data available at this time.

On a building by building basis, discussions were held on the history of the processes in the buildings, the type of contamination that would be found under the buildings, the year the buildings were erected, the probable depth of contamination and possible migration due to contamination in the water table. The following people attended the meeting and contributed to the discussions and assumptions:

L. J. Britcher - Earthline
L. H. Chapman - DOE Subcontractor
M. A. Edwards - Earthline Subcontractor
S. R. Foels - Earthline
J. A. Forschner - Earthline
G. D. Gammon - Earthline
J. R. Ganz - DOE
G. G. Gorsuch - DOE
J. W. Henderson - Earthline
S. E. Juterbock - Earthline
K. M. Lyle - Earthline
E. P. Marsh - Earthline
E. R. Senra - Earthline

Following the development of soil excavation quantities, a follow-up meeting will be held to determine the percentage of clean, contaminated, and mixed waste under the buildings. This will also be an assumption based on process knowledge, and will form the basis for sampling and disposal or treatment options and cost.

The following notes are the consensus assumptions arrived at by the above named individuals. For convenience, they are listed in WBS order rather that the order they were discussed:

FRP 4.0 Building Soil Excavation Assumptions

WBS 1.2.3.01 Soils Waste Management
Soils waste management is the Operations account for handling, processing, shipping, and disposal of contaminated building waste. There is **no excavation** associated with this WBS.

WBS 1.2.3.02 NE Billet Storage Building
This building was erected in 1984. Prior to 1984, the west wall was the exterior east wall of the High Bay. The accumulator bottle pits were adjacent to this wall. Previous excavation experience has shown that the building foundations channel contamination down from the surface. We will assume that excavation will be required for **four (4) feet** below the building foundation on the west wall. This will be next to the High Bay foundation that was assumed to require the same excavation. We will assume **three (3) feet** of excavation under the building floor and **one (1) foot** under all drain lines and the remaining building foundations.

WBS 1.2.3.03 Compressor Building
There was no actual processing in this building, but due to the proximity to the High Bay, and contamination washing out of the floor and off the roof, it will be assumed that contamination will extend approximately **three (3) feet** under the concrete and at least **one (1) foot** below any footers and drains that are below the three foot excavation. This excavation should fall within the High Bay lay back.

WBS 1.2.3.04 Truck Dock Area and Enclosed Truck Ramp
Originally the dock and ramp were set up as two separate WBS elements. In retrospect, they are an integral building and will be treated as a single WBS. The actual truck ramp was concrete prior to the start of processing in the 60's, and should be relatively clean. We will assume **six (6) inches** of excavation under the ramp area. The pit for the hydraulic truck lift at the bottom of the ramp extends about ten feet below the slab. Due to leaking oil over the operating years, we will assume contamination extends at least **three (3) feet** below the bottom of the pit. The drain at the end of the ramp is connected to the outfall line and will be assumed to be clean under and around the drain.

WBS 1.2.3.05 Emergency Equipment Storage Building
This building was not erected until 1987. It is a small building with a slab on grade. The ground under was not cleaned prior to construction. We will assume **two (2) feet** of excavation under the slab.

WBS 1.2.3.06 Enclosed Truck Ramp
See WBS 1.2.3.04

FRP 4.0 Building Soil Excavation Assumptions

WBS 1.2.3.07 Main Plant (Office Area & Ramp)
The current woman's locker room was added in 1979, and additional office area was added in 1983. The foundations in the Main Plant area have been shown to create a conduit for contamination. Since a portion of this building is original, and portions are added, we will assume the need to excavate **four (4) feet** under the building foundations and drain lines, but only **eighteen (18) inches** under the concrete slab.

WBS 1.2.3.07 Main Plant (High & Low Bay)
Water from the decon pad in the high bay overflowed into the press pit, and would have to be pumped out and treated. This was in addition to and fluids from the processing equipment itself. Since the pits are concrete and have cracks with a sump pump for water infiltration, it can be assumed that contamination also leaked out of the pit. The bottom of the lowest pit is 15.5 feet below floor level. The high and low bays had three known plus a fourth possible vertical quench tanks. Some people remember the fourth tank, but no drawings can be found for it. These tanks were concrete tanks approximately 18 feet deep with a three or four foot above ground wall.. All but one quench tank has been filled in by caving in the top concrete wall and filling with gravel and concrete to the floor level. The remaining quench tank was eventually lined with a stainless steel liner. This liner is presently empty and floats on top of groundwater that has leaked into the bottom of the concrete tank. The tank is one of the "hotter" spots in the plant. We have made the assumption that **four (4) feet** of excavation will be required under and around the lowest level of all in ground structures and foundations. This is an approximation, since pillars of dirt will not be left in place. The lowest level will be picked, and a safe working contour followed up from that point that includes at least four feet under the foundations. Due to groundwater at two levels within the 22 foot of excavation, we will need to assume that dewatering and treatment of the groundwater and rainwater is required, and that because of a potential de-stabilizing of the slope, a 1 to 1 lay back will be required.

WBS 1.2.3.08 Northwest Warehouse
This building was erected in 1984. There was approximately four feet of fill put in place prior to erecting the building. The fill was taken from other locations on site and no cleanup was performed prior to placement of the fill. Very limited testing data showed no significant contamination under the building. We will assume **six (6) inches** of excavation under the slab, and **one (1) foot** below all footings, grade beams, and drain lines. We will need to allow for extensive confirmatory sampling through the fill, down to original soil elevations to ensure no additional contamination is under the fill. In the south east corner of the building, there is a three foot deep sump. We should assume **two (2) feet** of excavation under and around the sump.

WBS 1.2.3.09 Hazardous Waste Storage Building
This building was originally used to store uranium billets and other processing supplies, and had a gravel floor. There is now a concrete floor and the building is designated as Hazardous Waste Storage Area #1. It is used to store both liquid and dry hazardous waste. We will assume **two (2) feet** of excavation is required under the slab, the foundations, and around the perimeter.
WBS 1.2.3.10 RF3 Butler Building

FRP 4.0 Building Soil Excavation Assumptions

Yellowcake was found adjacent to the RF3 Building during the excavation of Area D. Cleanup of the yellowcake required excavation to approximately eight feet. Due to this, and the high level of contamination in this building, we will assume that **six (6) feet** of excavation is required under the building, as well as **four (4) feet** outside the footprint of the building foundation, and **four (4) feet** under all foundations and drains. This will include the area around the catch basin on the north side of the building.

WBS 1.2.3.11 RF6 Butler Building
The RF6 was constructed in 1964 and contains two lab sumps, three lathe pits that were constructed in 1985, and the main RF6 sump that is approximately eight feet deep and eight feet in diameter. One of the lab sumps is the old lab area sump and is expected to be heavily contaminated. It is approximately four feet deep and square. The newer lab sumps support the modular laboratory and was installed in the early 90s. It is approximately 20 feet deep, but should not be heavily contaminated. We will assume **one (1) feet** of excavation under and around all drains, sumps, foundations, and the floor slab. Cleanup of the fire road to the south of the building was started in the early 90's when the modular buildings were installed. Soil was excavated down to six feet, and the ground was still contaminated. The trench was backfilled for fear of undermining the building foundation. This contamination could have washed off the roof, been washed out from the floor cleaning, or may be indicative of contamination spreading from the interior sumps. We will assume the contamination came from exteriors sources, and the contamination is limited to the fire road and immediately surrounding area. We will assume the fire road will need to be excavated **ten (10) feet** out from the building and to a depth of **ten (10) feet**. The lay back for this excavation will encompass the south RF6 foundation, but will not interfere with the present modular office location. If the contamination is more wide spread, we will process a change order at the time the full extent is known.

WBS 1.2.3.12 RF6 Butler Building Addition
With the exception of the acid neutralization floor sump, the RF6 Addition should be relatively clean. We will assume the same **one (1) foot** of excavation under the floor that was used for the main building, but will also use **one (1) foot** under and around foundations and drains. The exception will be for the floor sump. The sump was an open pit in the ground filled with limestone to neutralize acid. It was also used as a drain for washing the floor clean. We assume the contamination will have migrated fairly deep. The sump was approximately a three foot diameter. We will assume that we need to excavate to a depth of **twenty (20) feet**, and five (5) feet around the diameter of the pit, for a **thirteen (13) foot** diameter at the base of the excavation.

FRP 4.0 Building Soil Excavation Assumptions

WBS 1.2.3.13 Runout Table Filter Building (Stack 3)
There was minimal wet processing in this building, but due to the proximity to the High Bay, and contamination washing out of the floor and off the roof prior to construction, it should be assumed that contamination will extend approximately **three (3) feet** under the concrete, and at least **one (1) foot** below any footers and drains that are below the three foot excavation. This excavation should fall within the High Bay lay back.

WBS 1.2.3.14 Campbell Saw Filter Building (Stack 4)
There was minimal wet processing in this building, but due to the proximity to the High Bay, and contamination washing out of the floor and off the roof prior to construction, it should be assumed that contamination will extend approximately **three (3) feet** under the concrete, and at least **one (1) foot** below any footers and drains that are below the three foot excavation. This excavation should fall within the High Bay lay back.

WBS 1.2.3.15 Sewage Treatment Plant
This excavation includes the sewage treatment plant, the aeration tank, and the foundation for the original sewage treatment plant to the west of the present plant. The original plant was replaced in 1985, and will probably be more contaminated than the new plant. The aeration tank was used by both plants. The sewage holding tank is a steel tank 20 feet deep plus the thickness of the foundation. Since the tank is steel, it could be rusted and leaking. We will assume that we need to excavate **four (4) feet** under and around the diameter of the tank foundation. The lay back for this excavation should pick up most of the remaining building slab and foundation contamination. If anything falls outside of the lay back, assume **four (4) feet** of excavation below the low point.

WBS 1.2.3.16 CEI Substation
Limited test data has shown contamination to at least three feet around the substation. We will assume **four (4) feet** of excavation is required under and around the substation slab. There is approximately 5000 gallons of oil in the transformer. CEI assures us that the old transformer with PCB oil has been replaced. Exactly when it was replaced, and if there were any spills or leaks prior to, or during the replacement, is not known.

WBS 1.2.3.17 Waste Water Treatment Plant
Due to the water processing going on in this building, various leaks over the years, and the low level of the floor, we will assume **six (6) feet** of excavation under the floor, and **four (4) feet** under the tank foundations and the clear well. Because of the relatively small size of the building, this will probably mean six feet under the complete building, since it is not practical to leave soil pillars around the interior of the excavation.

FRP 4.0 Building Soil Excavation Assumptions

WBS 1.2.3.18 Tool Crib
The Tool Crib was built in 1984 and here was minimal wet processing in the building. Due to the proximity to the High Bay, and contamination washing out of the floor and off the High Bay roof prior to construction, it should be assumed that contamination will extend approximately **three (3) feet** under the concrete, and at least **one (1) foot** below any footers and drains that are below the three foot excavation. This excavation will probably fall within the High Bay lay back.

WBS 1.2.3.19 Die Head Filter Building (Stack 1A)
Although contamination is expected to be found under this foundation, it is problematic, since the lay back of the High Bay excavation will include the necessary excavation for cleanup of the Die Head Filter Building. The Die Head Filter Building is adjacent to the High Bay, and the High Bay is being excavation to a depth of 20 feet, with a one-to-one layback. When the building foundation was put in, a pipe was found at the bottom of the foundation that "pegged" the meter. The pipe was covered by the foundation, and is still in place. No one is sure what the pipe was from, and no one is sure of the exact location today. This pipe was cracked open, with a sludge in it. It will probably require additional cleanup when uncovered, but without additional data, no reasonable assumption can be made about excavation requirements for the old pipe. Due to the proximity to the High Bay, and contamination washing out of the floor and off the roof prior to construction, it should be assumed that contamination will extend approximately **three (3) feet** under the concrete, and at least **one (1) foot** below any footers and drains that are below the three foot excavation.

WBS 1.2.3.20 Old Incinerator
Yellowcake was found adjacent to the RF3 Building during the excavation of Area D. The incinerator facility was an open burn operation located just north of the RF3 Building. Cleanup of the yellowcake in Area D required excavation to approximately eight feet. Due to this and the high level of contamination in RF3 and the incinerator area, we will assume that **six (6) feet** of excavation is required under the building, as well as **four (4) feet** outside the footprint of the building foundation.

WBS 1.2.3.21 RMI (Indoor) Substation
There was no actual processing in this building, but due to the proximity to the High Bay, and contamination washing out of the floor and off the roof, it should be assumed that contamination will extend approximately **three (3) feet** under the concrete, and at least **one (1) foot** below any footers and drains that are below the three foot excavation. This excavation should fall within the High Bay lay back.

FRP 4.0 Building Soil Excavation Assumptions

WBS 1.2.3.22 Outdoor Substation

This building was added in 1987. It is attached to the east side of the Stack 1A building and will probably cleaned up at the same time. We will use the same assumptions as the Stack 1A Building excavation which is to excavate **three (3) feet** under the concrete slab and at least **one (1) foot** below any footers and drains that are below the three foot excavation. This excavation will probably fall within the High Bay lay back.

WBS 1.2.3.23 Modular Laboratory

This building was put in place after production was stopped. Prior to placement of the laboratory units, soil was excavated until contamination fell within acceptable limits. We will assume that the soil under the office complex has remained clean and that **no excavation** will be required. So long as the RF6 fire road excavation does not extend beyond ten feet wide and 10 feet deep, the Modular Laboratory foundation will not be effected by the excavation.

WBS 1.2.3.24 ES&H (Operations) Office Building

The ES&H building existed prior to start of operations, and should be clean underneath. It is one of two buildings proposed to remain after cleanup. The building will be thoroughly cleaned, the roof replaced, and confirmatory sampling conducted, but **no excavation** is planned for under the building.

WBS 1.2.3.25 Modular Offices

This building complex was put in place after production was stopped. Prior to placement of the office units, soil was excavated until contamination fell within acceptable limits. We will assume that the soil under the office complex has remained clean and that **no excavation** will be required. A sampling well located under the modular office complex is showing increasing levels of water contamination. Until further information is know about this contamination, we will not plan any action for cleanup of the groundwater. So long as the RF6 fire road excavation does not extend beyond ten feet wide and 10 feet deep, the Modular Office foundation will not be effected by the excavation.

WBS 1.2.3.26 Guardhouse

The guardhouse existed prior to start of operations, and is believed to be clean underneath. It is one of two buildings proposed to remain after cleanup. The building will be thoroughly cleaned, the roof replaced, and confirmatory sampling conducted, but **no excavation** is thought to be required under the building.

WBS 1.2.3.27 Temporary Facilities

Temporary facilities include any trailers that are presently on site, or will be added in the future. Since there are no concrete slabs planned for the trailer facilities, any excavation required will be **part of the general soil remediation** planned for the area they will be located. (Area B, C, or D).

FRP 4.0 Building Soil Excavation Assumptions

WBS 1.2.3.28 Mixed Waste

This WBS covers the processing of building mixed waste, rather than a specific location. **No excavation** will be associated with this WBS.

WBS 1.2.3.29 Soil Washing Plant

The soil washing plant was only erected in 1998 and was checked for contamination prior to placing the slab and foundation. We will assume the soil under the slab is clean with the exception of the drain sump in the middle of the building, **no excavation** is expected to be required beyond the removal of the slab and foundation.. The sump was poured prior to the floor slab. The contractor left the wooden forms at the top of the sump in place when they placed the floor slab. The wood shrunk and left a migration point for water at the top of the slab that was not discovered for a period of time. We will assume that excavation will be required **two (2) feet** under and around the sump.

WBS 1.2.3.30 Soil Storage Building

This building was erected in 1999/2000. Prior to placement of the building, soil was excavated until contamination fell within acceptable limits. We will assume that the soil under the building will remain clean and that **no excavation** is expected to be required beyond the removal of the floor and foundation.

WBS 1.2.3.31 Waste Processing Building

This building will be erected to support waste processing as other buildings are demolished. It is planned to be a temporary building, but will still require a concrete floor and foundation. Since the building will be erected after production was stopped and will be built on clean soil, we will assume that the soil under the building will remain clean and that **no excavation** will be required beyond the removal of the floor and foundation. The trailers that will be attached to the temporary waste processing building will be included in WBS 1.2.3.27, Temporary Facilities.

WBS 1.2.3.32 NPDES Facility

This facility is currently under design. It will include some type of mixing station and instrumentation, It may be a pit in the ground, but it appears that a 500,000 or larger settling tank will be required as part of the facility. Since the facility will be erected after production was stopped and will be built on clean soil, we will assume that the soil under the facility will remain clean and that **no excavation** is expected to be required beyond the removal of the any required piping, concrete and foundation.

WBS 1.2.3.33 Mobile Equipment

This WBS includes the infrastructure equipment that is required to support remediation. The equipment is not associated with any specific building or soil area, and **no excavation** will be included with this WBS.

WBS 1.3.2.01 Soils Excavation (miscellaneous areas)

Manhole #1

Manhole #1 is 18 feet deep. During operations, the outfall was at the bottom of the manhole and little or no water stood in the pit. During excavation of Area D, yellow cake was found in the area leading to Manhole #1. Because the manhole was in poor condition and crumbling, excavation was stopped approximately 10 feet short of the manhole. Yellowcake is still remaining in the area up to the manhole. We will assume the we need to excavate **ten (10) feet** to the south where the yellowcake still exists, and **four (4) feet** beyond the other sides and under the bottom of the pit.

Parking Lot

The parking lot outside of the fence was only partially paved when operations started. We will assume that there is contamination under the asphalt, as well as mixed in the various layers of asphalt and sealants. Since the exact dimensions of the paved versus unpaved area is not immediately available, we will assume **six (6) inches** of excavation under the whole parking lot. It will probably be one foot under the original unpaved area, and clean under the remainder. All of the asphalt will be considered contaminated.

Utilities

Underground utilities will require an excavation at least **three (3) feet** wide, and **one (1) foot** under the utility line. This includes drains, water lines, gas lines, and electrical lines. The three foot width is considered the minimum width for a person to get in the trench and verify contamination conditions. If the excavation is more that three feet deep, a trench box will be required while people are in the trench, or a one-to-one lay back will be required. The trench box may not be feasible, since the trench will have to remain open until all work is completed and the ODH completes an independent verification of the clean state.